PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Hironori Kakiuchi et al.
Application No.	:	10/764,805
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For	:	OPTICAL RECORDING MEDIUM

Examiner	:	Martin J. Angebranndt
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Docket No.	:	890050.457
Date	:	March 16, 2009

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Commissioner for Patents
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Alexandria, VA 22313-1450

APPELLANT'S BRIEF

Commissioner for Patents:

This brief is in furtherance of the Notice of Appeal, filed in this case on January 16, 2009. The fees required under Section 41.20(b)(2), and any required request for extension of time for filing this brief and fees therefor, are dealt with in the accompanying transmittal letter.

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I. REAL PARTY IN INTEREST

The real party in interest is TDK Corporation, the assignee, as evidenced by the assignment set forth at Reed 014935, Frame 0758. The assignment of record is to TDK Corporation, having an address at 1-13-1 Nihonbashi Chuo-ku, 103-8272, Tokyo, Japan.

II. RELATED APPEALS AND INTERFERENCES

Appellant, Appellant's legal representative and assignee are unaware of any appeal, interference, or judicial proceeding which may be related to, directly affect, be directly affected by, or have a bearing on the Board's decision in this appeal.

III. STATUS OF CLAIMS

Claims 1-25 are pending. Claims 1-25 stand rejected by the Examiner as noted in the Office Action mailed on October 17, 2008. All rejected claims are appealed.

IV. STATUS OF AMENDMENTS

A final Office Action was mailed on April 10, 2008. In response to this final Office Action, a Notice of Appeal was filed on June 30, 2008. An Amendment and Request for Continued Examination were subsequently filed on August 21, 2008. A non-final Office Action was mailed on October 17, 2008. In response to this non-final Office Action, a Notice of Appeal was filed on January 16, 2009. No amendment has been filed in response to the non-final Office Action of October 17, 2008 (hereinafter referred to as the "Office Action").

V. SUMMARY OF CLAIMED SUBJECT MATTER

Optical recording media such as compact discs (CD), digital video discs (DVD) and the like have been widely used as data recording media for recording audio, video and/or textual data. The optical recording media available on the market are typically in the form of a flat, circular disc made of polycarbonate plastic. In general, optical recording media fall into one of three categories: (1) read-only memory (ROM) type optical recording media, such as CD-ROM and DVD-ROM, which are prerecorded and do not allow writing or rewriting of data; (2) rewritable type optical recording media, such as CD-RW and DVD-RW, which allow writing and rewriting of data on the disc; and (3) write-once type optical recording media, such as CD-R and DVD-R, which allow data to be written once to the disc but do not allow rewriting of data thereafter.

Depending on the type of an optical recording medium, different approaches are employed to record data onto and read data from the optical recording medium. For a ROM type optical recording medium, data is prerecorded as a series of microscopic indentations, or pits, during the manufacturing process. When reading the recorded data with a laser beam, phase of the reflected beam is shifted because of the pits, and this phase shift changes the reflected beam's intensity that is used to recover the recorded binary data. For a rewritable type optical recording medium, data is recorded using a laser beam to selectively heat and melt the recording layer, which is often composed of a phase change material in a crystalline state, into an amorphous state or to anneal it at a lower temperature back to its crystalline state. When reading the recorded data with a laser beam, varying reflectance of the recording layer as a result of phase change appear like the pits of a ROM type optical recording medium.

A conventional write-once type optical recording medium typically contains a layer of organic dye, such as a cyanine dye, phthalocyanine dye or azo dye, within the disc as a recording layer. When writing data to a write-once type optical recording medium, a laser beam heats up portions of the organic dye causing chemical change in those portions of the dye. This chemical change causes a change in an optical characteristic of the dye. Data is read by irradiating the recording layer with a lower power laser beam and measuring some parameter of the reflected beam. However, since an organic dye is degraded when exposed to sunlight or the

like, a common problem with the conventional write-once type optical recording media is that it is difficult to improve the long-term storage reliability when an organic dye is used in the recording layer.

A prior art solution to this problem is to form an optical recording medium by laminating two recording layers that are not made of an organic dye. Although this prior art solution seems to address the reliability problem due to degradation of organic dye, it nevertheless creates two new problems. One problem is that it is difficult to store the initially recorded data in the recording layers in a good condition over the long term. The other problem is that the initial recording characteristic may be poor since the surface smoothness of an optical recording medium in accordance with this prior art solution is not necessarily good.

Embodiments of the invention are believed to solve the problems related to the conventional write-once type optical recording media and the prior art solution just described. Namely, embodiments of the invention, as will now be described, provide a write-once type optical recording medium that has an excellent initial recording characteristic and can store recorded data in a good condition over the long term.

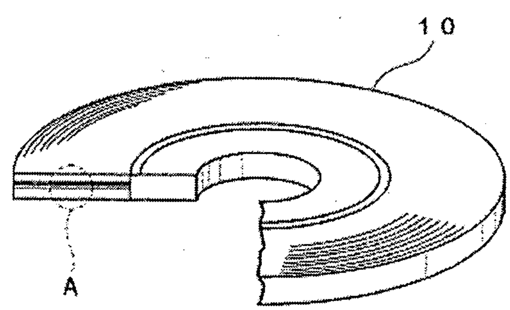


Figure 1
(Figure 1 of the application)

A portion of an optical recording medium according to an embodiment of the invention is shown in Figure 1. A cross-sectional portion of the optical recording medium, as indicated by the circular mark A in Figure 1, shows that the disc is made from several different layers. As with a conventional write-once type optical recording medium, the optical recording medium according to embodiments of the invention is in the form of a flat, circular disc with an outer diameter of about 120 mm and a thickness of about 1.2 mm. In other words, an optical

recording medium according to an embodiment of the invention is compatible with a conventional optical recording medium in terms of functionality, shape and form. One critical difference, however, is that an optical recording medium according to an embodiment of the invention does not use dyestuff such as an organic dye in the recording layer where data is recorded.

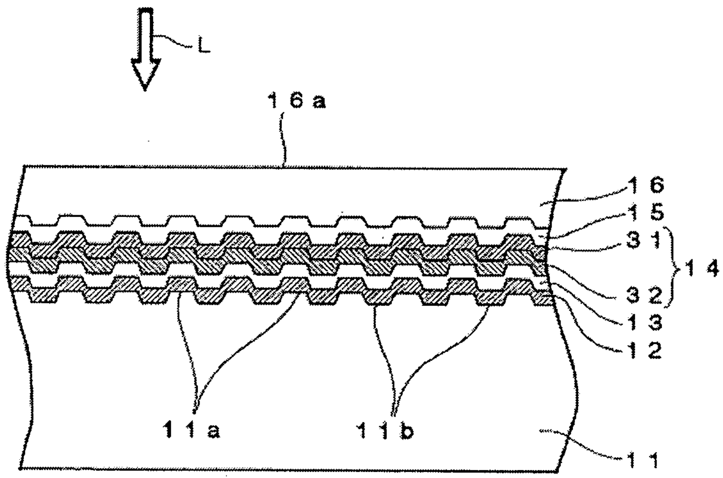


Figure 2
(Figure 2 of the application)

Figure 2 shows a partially enlarged schematic of a cross-sectional portion of the optical recording medium from Figure 1. This is representative of the several layers which form an optical recording disc according to an embodiment of the invention.

The disc includes a support substrate 11 that serves as a support for ensuring mechanical strength and can be formed from any number of materials. Grooves 11a and lands 11b are formed on the surface of the substrate 11 in a spiral track around the disc and serve as a guide track for the laser beam L. See pages 12-13 of the application as filed, a copy of which is attached as Evidence Exhibit A for ease of reference.

A reflective layer 12 is formed over the grooves 11a and lands 11b of the substrate 11 to reflect the laser beam L entering through a light transmission layer 16 so as to emit from the light transmission layer 16. The reflective layer 12 may be formed from any of a large group of materials, and preferably a metal material having a high reflection characteristic, such as Al, Au, Ag, Cu or an alloy of Al and Ti, for example. This is because a high reflection

characteristic enables the reflective layer 12 to serve the function it is intended for—reflecting the laser beam L—and serve it well. Data is not recorded in the reflective layer 12, and the reflective layer 12 is not a part of a recording layer 14 where data is recorded in the disc. See page 14 of the application as filed.

A first dielectric layer 15 and a second dielectric layer 13, between which the recording layer 14 is disposed, serve to protect the recording layer 14, so that degradation of optically recorded data can be prevented over a long period of time. The light transmission layer 16 is formed on the surface of the first dielectric layer 15, as shown in Figure 1. See also page 14 of the application as filed.

Unlike recording and reading data with conventional write-once optical recording media, a write-once optical recording medium according to embodiments of the invention does not rely on change in an optical characteristic of an organic dye to record or read data. Nor is data recorded using uneven pits or grooves. Rather, a very different principle of operation is utilized. The recording layer 14 does not contain a dyestuff film or any organic dye but is formed by laminating a first recording film 31 and a second recording film 32. The first recording film 31 contains Si as a primary component in one embodiment, and contains an element selected from the group consisting of Ge, Sn, Mg, In, Zn, Bi and Al as a primary component in other embodiments. That is, whichever element in the above list being the primary component, the content of the primary component is the maximum among the elements contained in the first recording film 31. In one embodiment, the second recording film 32 contains Cu as a primary component with 10 to 30 atomic % of Al as an additive. In particular, the content of Cu is the maximum among the elements contained in the second recording film 32. See pages 5 and 16 of the application as filed.

Through vigorous research and development Appellants discovered that, by employing a recording layer 14 having the first recording film 31 and the second recording film 32 with such compositions, advantageous results unseen in conventional write-once optical recording media and the prior art solution can be achieved as will be discussed below.

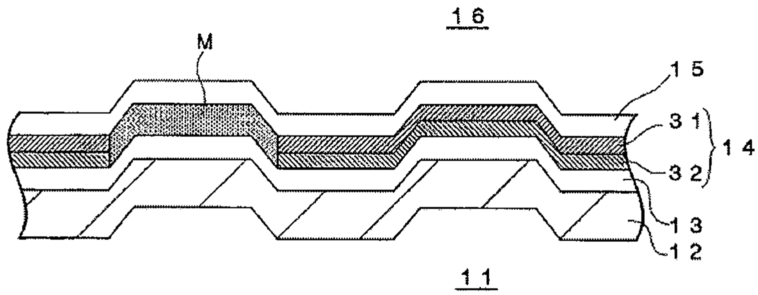


Figure 3
(Figure 3 of the application)

To record data, a laser beam L is irradiated onto the recording layer 14 to cause a record mark M to form within the recording layer 14 as a result of a mixture of the primary component of the elements forming the first recording film 31 and the primary component of the elements forming the second recording film 32, as shown in Figure 3. It has been discovered that as the record mark M is formed due to a mixture of the primary component of the elements forming the first recording film 31 and the primary component of the elements forming the second recording film 32, the resultant reflection coefficient of the record mark M is greatly different from the reflection coefficient of a region surrounding the record mark M where no such mixture is formed. See page 19 of the application as filed.

This large differential in reflection coefficient provides several benefits. Firstly, data with high sensitivity can be recorded. Secondly, data initially recorded with high sensitivity can also be stored for a long time. Thirdly, a reproduced signal with high C/N ratio can be obtained when recorded data are reproduced. Furthermore, it has also been discovered that, if the second recording film 32 contains Cu as the primary component with 10 to 30 atomic % of Al as an additive, jitter of a reproduced signal can be decreased. See pages 19-20 of the application as filed.

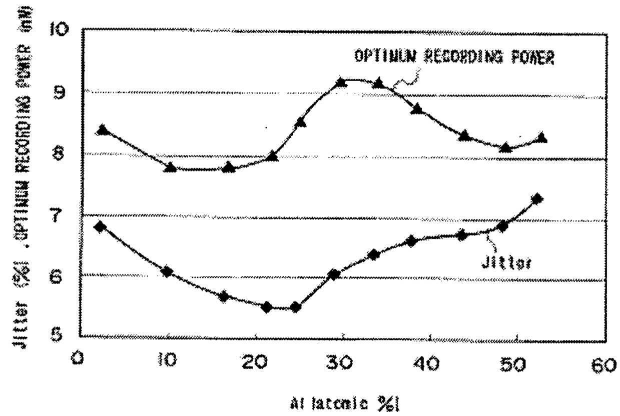


Figure 4
(Figure 17 of the application)

As shown in Figure 4, Appellants have found that in the case where the amount of Al added to the second recording film 32 was 10 to 30 atomic %, jitter of the reproduced signal could be sufficiently reduced to a level equal to or lower than 6%. It was also found that in the case where the amount of Al added to the second recording film 32 was 20 to 25 atomic %, jitter of the reproduced signal could be markedly reduced. When the amount of Al added to the second recording film 32 was equal to or less than 25 atomic %, the optimum recording power of the laser beam was equal to or lower than 8. mW, thus improving the recording sensitivity. Further, when the amount of Al added to the second recording film 32 was 10 to 20 atomic % the optimum recording power of the laser beam was equal to or lower than 8.0 mW and the recording sensitivity was markedly improved. See page 37 of the Application. Clearly, composition of the elements in the recording films 31 and 32, particularly in the second recording film 32, plays a significant role. In the case of the second recording film 32, not only it is critical to have Cu as the primary component with Al as an additive, it is also important to control the atomic % of Al in the second recording film 32 to be within a desired range for optimal results.

Favorable results stemming from recording data using an optical recording medium in accordance with embodiments of the invention extend beyond reduction of jitter and improvement of recording sensitivity. In their experiments, Appellants have found that the difference in light transmittances for the laser beam L having a wavelength of 350 nm to 450 nm between the region where a record mark M is formed by mixing Si and Cu and a blank region of

the recording layer is equal to or lower than 3%. Additionally, the difference in light transmittances for the laser beam L having a wavelength of about 405 nm between the region where a record mark M is formed and a blank region is equal to or lower than 1%. See page 28 of the application as filed.

Small difference in light transmittances between the region where a record mark M is formed by mixing Si and Cu and a blank region means the amount of light that passes through the record mark M formed by mixing Si and Cu differs minimally from the amount of light that passes through the black region. This characteristic is especially desirable when there is more than one recording layer in the optical recording medium. In an optical recording medium having at least an upper recording layer and a lower recording layer where the upper recording layer is closer to the light incidence plane through which a laser beam enters the optical recording medium than the lower recording layer is, the amount of light that reaches the lower recording layer or the amount of light that is reflected from the lower recording surface hardly changes whether the light passes through a blank region or a region where a record mark M is formed by mixing Si and Cu. To say the least, this advantageously allows data to be recorded on and reproduced from the lower recording layer without negative impact on the integrity of the reproduced data.

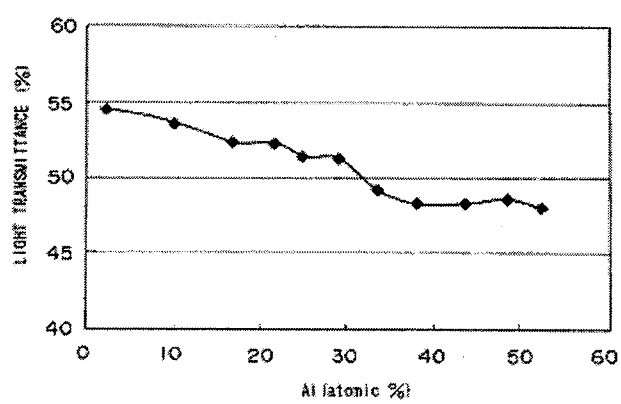


Figure 5
(Figure 18 of the application)

As shown in Figure 5, in samples where the amount of Al added to a recording film was 10 to 30 atomic %, the light transmittance of the recording film was equal to or higher

than 50%. Therefore, a recording film according to embodiments of the invention can still have sufficiently high light transmittance. This favorable characteristic provides several advantages.

With sufficiently high light transmittance in a recording layer and a small difference in light transmittances between the region where a record mark M is formed by mixing Si and Cu and a blank region, the recording characteristics of the recording layer can be markedly improved especially when there are multiple recording layers in a disc. This is because the amount of the laser beam projected through an upper recording layer onto a lower recording layer hardly changes. That is, in embodiments of the invention the amount of light passing through the optical recording medium from one layer to another does not change so much to the extent that recording characteristics would be compromised. In addition, when data are reproduced from a lower recording layer in a multi-recording layer disc, it is possible to prevent the amplitude of a signal reproduced from the lower recording layer from changing greatly, since the amount of the laser beam reflected from the lower recording layer and detected hardly changes. Furthermore, when data recorded in a lower recording layer of a multi-recording layer disc are reproduced, even if the region of an upper recording layer through which the laser beam passes contains a boundary between a region where a record mark M is formed and a blank region, data recorded in the lower recording layer can still be reproduced in a desired manner. See pages 28-29 of the application as filed.

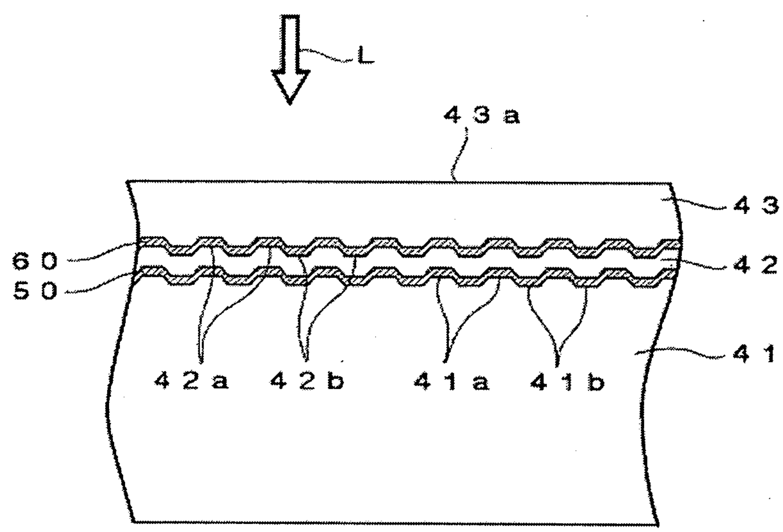


Figure 6
(Figure 8 of the application)

Figure 8 shows a partially enlarged schematic of a cross-sectional portion of an optical recording medium according to another embodiment of the invention that includes more than one recording layer. This embodiment includes a support substrate 41, a transparent intermediate layer 42 and multiple recording layers, namely a light transmission layer 43, an L0 information recording layer 50 and an L1 information recording layer 60. A laser beam L enters the optical recording medium through a light incidence plane 43a for recording and reading data. See page 22 of the application as filed.

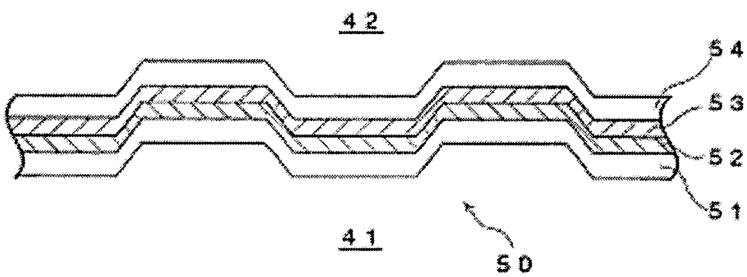


Figure 7
(Figure 9 of the application)

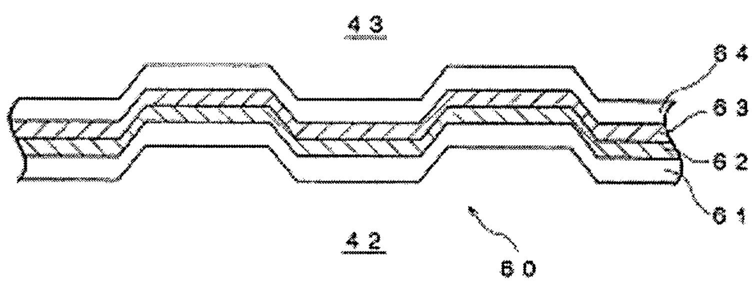


Figure 8
(Figure 10 of the application)

Figure 7 and Figure 8 are schematic enlarged cross-sectional views showing details of the L0 information recording layer 50 and the L1 information recording layer 60, respectively. As shown in Figure 7, the L0 information recording layer 50 is constituted by laminating a fourth dielectric film 51, a second L0 recording film 52, a first L0 recording film 53 and a third dielectric film 54. As shown in Figure 8, the L1 information recording layer 60 is constituted by laminating a second dielectric film 61, a second L1 recording film 62, a first L1 recording film 63 and a first dielectric film 64. See page 24 of the application as filed.

Similar to the recording films 31 and 32, the first L0 recording film 53 contains Si as a primary component and the second L0 recording film 52 contains Cu as a primary component with 10 to 30 atomic % of Al as an additive. Likewise, the first L1 recording film 63 contains Si as a primary component and the second L1 recording film 62 contains Cu as a primary component with 10 to 30 atomic % of Al as an additive. See page 24 of the application as filed.

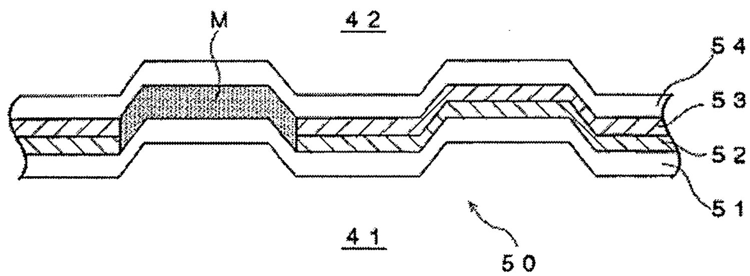


Figure 9
(Figure 11 of the application)

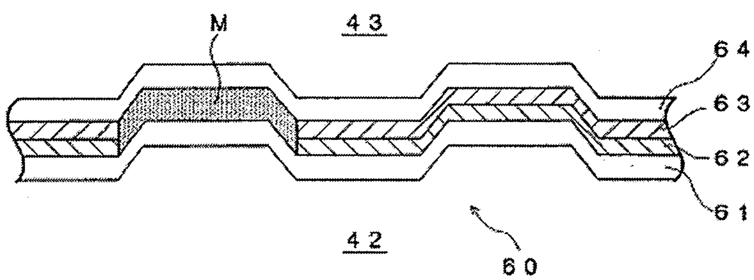


Figure 10
(Figure 12 of the application)

Figure 9 and Figure 10 show the L0 information recording layer 50 and the L1 information recording layer 60, respectively, after they have been irradiated with a laser beam to form a record mark M within the information recording layer. In particular, in the L0 information recording layer 50, the record mark M is formed when the primary component Si of the first L0 recording film 53 and the primary component Cu of the second L0 recording film 52 are mixed upon irradiation. As previously described, the reflection coefficient of the region where the record mark M is formed greatly changes. Similarly, in the L1 information recording

layer 60, the record mark M is formed when the primary component Si of the first L1 recording film 63 and the primary component Cu of the second L1 recording film 62 are mixed upon irradiation. Again, the reflection coefficient of the region where the record mark M is formed greatly changes. The resultant reflection coefficient of the record mark M is greatly different from the reflection coefficient of a region surrounding the record mark M where no such mixture is formed, and this large differential in reflection coefficient brings several benefits as described above. See pages 25-26 of the application as filed.

An optical recording medium having multiple recording layers according to the embodiments shown in Figures 6-10 still enjoys improved recording characteristics thanks to the sufficiently high light transmittance. Using a recording film having Cu as the primary component and 10 to 30 atomic % of Al as an additive in each recording layer, the amount of the laser beam projected through an upper recording layer onto a lower recording layer hardly changes. In addition, when data are reproduced from a lower recording layer in a multi-recording layer disc, it is possible to prevent the amplitude of a signal reproduced from the lower recording layer from changing greatly, since the amount of the laser beam reflected from the lower recording layer and detected hardly changes. Furthermore, when data recorded in a lower recording layer of a multi-recording layer disc are reproduced, even if the region of an upper recording layer through which the laser beam passes contains a boundary between a region where a record mark M is formed and a blank region, data recorded in the lower recording layer can still be reproduced in a desired manner. See pages 28-29 of the application as filed.

Embodiments of the invention address the problem of reliability related to degradation of dye that is suffered by conventional write-once type optical recording media, because no dye is used in the embodiments. Embodiments of the invention also address the problems encountered by the aforementioned prior art solution, and thus an optical recording medium according to an embodiment of the invention has an excellent initial recording characteristic and can store recorded data in a good condition over the long term. This is because the region where a record mark is formed by the mixture of a first recording film having Si as the primary component and a second recording film having Cu as the primary component with 10 to 30 atomic % of Al as an additive has a reflection coefficient that is greatly different from the reflection coefficient of a blank region surrounding the region where the record mark is formed.

This advantageously allows data with high sensitivity to be recorded and allows data initially recorded with high sensitivity to be stored for a long time. Other additional advantages provided by embodiments of the invention include: a high C/N ratio in reproduced data, reduced jitter in produced signals, and sufficiently high light transmittance that allows data to be recorded to and reproduced from a lower recording layer in a multi-recording layer disc.

The prior summary and the following claim references are to provide a discussion of the subject matter of the application as required by the appeal rules, along with references to portions of the specification and drawings. The scope of the pending claims are to be construed by their own words and not by this summary or limited to the specific elements as labeled in the claims.

Claims

Hereafter is a concise listing of the claims whose allowability are under appeal, correlated with an example of subject matter from the specification on which each element reads. For brevity, correlated subject matter is provided in connection with the reference numeral along with the page number and line number in the application as filed of the first instance of each element, with subsequent instances noted simply by reference numerals. This listing is provided for the purpose of simplifying review of the claims and subject matter. It is not to be construed as limiting the claims to the specific subject matter referenced, nor to the embodiments disclosed in the specification.

1. An optical recording medium comprising:

a substrate [11] (**12:14-21**; Figure 2)[1];

a reflective layer [12] (**12:14-21**; Figure 2);

a light transmission layer [16] (**12:14-21**; Figure 2); and

at least one recording layer [14] (**12:14-21**; Figure 2) positioned between the reflective layer [12] and the light transmission layer [16], the recording layer [14] being of the type in which data can be recorded by projecting a laser beam [L] (**12:22-26**; Figure 2), the

[1] For brevity, the specific passage of the specification where a claimed element is first cited will be indicated in bold by a page number separated from a line number by a colon, e.g., 3:12, indicating page 4, line 12 of the specification.

recording layer [14] including a first recording film [31] (**16:15-17**; Figure 2) containing an element selected from the group consisting of Si, Ge, Sn, Mg, In, Zn, Bi and Al as a primary component (**40:19-25**) and a second recording film [32] (**16:15-17**; Figure 2) containing Cu as a primary component and 10 to 30 atomic % of Al as an additive (**16:22-24**),

wherein the element contained in the first recording film [31] as a primary component and the element contained in the second recording film [32] as a primary component are mixed upon irradiation with the laser beam [L] (**25:10-25**), and

wherein the light transmission layer [16] is disposed on the opposite side to the substrate [11] with respect to the recording layer [14] and one surface of the light transmission layer [16] constitutes a light incidence plane [16a] (**12:22-26**; Figure 2) through which the laser beam [L] enters the optical recording medium [10] (**12:14-21**; Figure 1).

2. An optical recording medium in accordance with Claim 1, wherein the second recording film [32] is formed so as to be in contact with the first recording film [31] (**38:28-39**, line 11; Figure 2).

3. An optical recording medium in accordance with Claim 1, wherein the second recording film [32] contains 10 to 25 atomic % of Al (**17:4-5**).

4. An optical recording medium in accordance with Claim 3, wherein the second recording film [32] contains 20 to 25 atomic % of Al (**17:4-5**).

5. An optical recording medium in accordance with Claim 1, which further comprises a first dielectric layer [15] (**12:14-21**; Figure 2) and a second dielectric layer [13] (**12:14-21**; Figure 2) on the both sides of the recording layer [14].

6. An optical recording medium in accordance with Claim 2, which further comprises a first dielectric layer [15] and a second dielectric layer [13] on the both sides of the recording layer [14].

7. An optical recording medium in accordance with Claim 3, which further comprises a first dielectric layer [15] and a second dielectric layer [13] on the both sides of the recording layer [14].

8. An optical recording medium in accordance with Claim 4, which further comprises a first dielectric layer [15] and a second dielectric layer [13] on the both sides of the recording layer [14].

9. An optical recording medium in accordance with Claim 1, wherein the light transmission layer [16] has a thickness of 10 to 300 μm **(18:19-21)**.

10. An optical recording medium in accordance with Claim 1, wherein the laser beam [L] has a wavelength of 380 nm to 450 nm **(19:8-11)**.

11. An optical recording medium comprising:

a substrate [11] **(12:14-21**; Figure 2);

a reflective layer [12] **(12:14-21**; Figure 2);

a light transmission layer [16] **(12:14-21**; Figure 2);

a plurality of information record layers [50, 60] **(22:21-23:1**; Figure 8) positioned between the reflective layer [12] and the light transmission layer [16], the recording being of the type in which data can be recorded by projecting a laser beam [L] **(22:21-23:1** Figure 8) thereonto via the light transmission layer [16], at least one information recording layer [60] other than an information recording layer [50] farthest from a light incidence plane [43a] **(22:21-23:1**; Figure 8) through which a laser beam [L] enters including a first recording film [63] **(24:13-15**; Figure 10) containing an element selected from the group consisting of Si, Ge, Sn, Mg, In, Zn, Bi and Al as a primary component **(40:19-25)** and a second recording film [62] **(24:13-15**; Figure 10) containing Cu as a primary component and 10 to 30 atomic % of Al as an additive **(16:22-24)**,

wherein the element contained in the first recording film [63] as a primary component and the element contained in the second recording film [62] as a primary component are mixed upon irradiation with the laser beam [L] **(26:1-6)**; and

wherein the light transmission layer [16] is disposed on the opposite side to the substrate [11] with respect to the recording layer [14] and one surface of the light transmission layer [16] constitutes a light incidence plane [16a] **(12:22-26**; Figure 2) through which the laser beam [L] enters the optical recording medium [10] **(12:14-21**; Figure 1).

12. An optical recording medium in accordance with Claim 11, wherein the second recording film [32] is formed so as to be in contact with the first recording film [31] **(38:28-39:11**; Figure 2).

13. An optical recording medium in accordance with Claim 11, wherein the second recording film [32] contains 10 to 25 atomic % of Al **(17:4-5)**.

14. An optical recording medium in accordance with Claim 13, wherein the second recording film [32] contains 20 to 25 atomic % of Al **(17:4-5)**.

15. An optical recording medium in accordance with Claim 11, wherein the light transmission layer [16] has a thickness of 10 to 300 μm **(18:19-21)**.

16. An optical recording medium in accordance with Claim 12, wherein the light transmission layer [16] has a thickness of 10 to 300 μm **(18:19-21)**.

17. An optical recording medium in accordance with Claim 13, wherein the light transmission layer [16] has a thickness of 10 to 300 μm **(18:19-21)**.

18. An optical recording medium in accordance with Claim 14, wherein the light transmission layer [16] has a thickness of 10 to 300 μm **(18:19-21)**.

19. An optical recording medium in accordance with Claim 11, wherein the laser beam [L] has a wavelength of 380 nm to 450 nm (**19:8-11**).

20. An optical recording medium in accordance with Claim 1, wherein the difference in the light transmittances of a mixed region of the first recording film [31] and the second recording film [32] and a region where the first recording film [31] and the second recording film [32] do not mix with each other is equal to or less than 3% (**28:6-16**) for a laser beam [L] having a wavelength of 380 nm to 450 nm (**28:6-16**).

21. An optical recording medium in accordance with Claim 20, wherein the difference in the light transmittances of a mixed region of the first recording film [31] and the second recording film [32] and a region where the first recording film [31] and the second recording film [32] do not mix with each other is equal to or less than 1% **28:6-16)** for a laser beam [L] having a wavelength of 380 nm to 450 nm (**28:6-16**).

22. An optical recording medium in accordance with Claim 11, wherein the difference in the light transmittances of a mixed region of the first recording film [31] and the second recording film [32] and a region where the first recording film [31] and the second recording film [32] do not mix with each other is equal to or less than 3% (**28:6-16**) for a laser beam [L] having a wavelength of 380 nm to 450 nm (**28:6-16**).

23. An optical recording medium in accordance with Claim 22, wherein the difference in the light transmittances of a mixed region of the first recording film [31] and the second recording film [32] and a region where the first recording film [31] and the second recording film [32] do not mix with each other is equal to or less than 1% (**28:6-16**) for a laser beam [L] having a wavelength of 380 nm to 450 nm (**28:6-16**).

24. An optical recording medium comprising:

a substrate [11] (**12:14-21**; Figure 2);

a reflective layer [12] (**12:14-21**; Figure 2);

a light transmission layer [16] (**12:14-21**; Figure 2); and

at least one recording layer [14] (**12:14-21**; Figure 2) positioned between the reflective layer [12] and the light transmission layer [16], the recording being of the type in which data can be recorded by projecting a laser beam [L] (**12:22-26**; Figure 2) thereonto via the light transmission layer [16], the recording layer [14] including a first recording film [31] (**16:15-17**; Figure 2) containing an element selected from the group consisting of Si, Ge, Sn, Mg, In, Zn, Bi and Al as a primary component (**40:19-25**) and a second recording film [32] (**16:15-17**; Figure 2) containing Cu as a primary component and 10 to 30 atomic % of Al as an additive (**16:22-24**),

wherein the difference in the light transmittances of a mixed region of the first recording film [31] and the second recording film [32] and a region where the first recording film [31] and the second recording film [32] do not mix with each other is equal to or less than 3% (**28:6-16**) for a laser beam [L] having a wavelength of 380 nm to 450 nm (**28:6-16**); and

wherein the light transmission layer [16] is disposed on the opposite side to the substrate [11] with respect to the recording layer [14] and one surface of the light transmission layer [16] constitutes a light incidence plane [16a] (**12:22-26**; Figure 2) through which the laser beam [L] enters the optical recording medium [10] (**12:14-21**; Figure 1).

25. An optical recording medium in accordance with Claim 24, wherein the difference in the light transmittances of a mixed region of the first recording film [31] and the second recording film [32] and a region where the first recording film [31] and the second recording film [32] do not mix with each other is equal to or less than 1% (**28:6-16**) for a laser beam [L] having a wavelength of 380 nm to 450 nm (**28:6-16**).

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

1. Whether claims 1-25 are unpatentable under 35 U.S.C. § 103(a) over Chinese Patent No. 1330368 to Xu et al. or U.S. Patent Application Publication No. 2004/0021160 by Shuy et al., in view of U.S. Patent No. 6,033,752 to Suzuki et al., U.S. Patent No. 4,670,345 to Morimoto et al., Japanese Patent Application Publication No. 59-225992 by Shigeta et al. and Japanese Patent Application Publication No. 2000-285509 by Kinoshita et al., combined with either of Japanese Patent Application Publication No. 10-143919 by Yoshida or European Patent No. 1122723 to Aratani et al.?

VII. ARGUMENT

All claims were rejected over Chinese Patent No. 1330368 to Xu et al. (hereinafter "Xu") or U.S. Patent Application Publication No. 2004/0021160 by Shuy et al. (hereinafter "Shuy"), in view of U.S. Patent No. 6,033,752 to Suzuki et al. (hereinafter "Suzuki"), U.S. Patent No. 4,670,345 to Morimoto et al. (hereinafter "Morimoto"), Japanese Patent Application Publication No. 59-225992 by Shigeta et al. (hereinafter "Shigeta") and Japanese Patent Application Publication No. 2000-285509 by Kinoshita et al. (hereinafter "Kinoshita"), combined with either of Japanese Patent Application Publication No. 10-143919 by Yoshida (hereinafter "Yoshida") or European Patent No. 1122723 to Aratani et al. (hereinafter "Aratani").

A. Discussion of the Art of Record.

Provided hereinafter are brief discussions of the references relied upon by the Examiner in rejecting the claims under 35 U.S.C. § 103(a). The Xu reference and the Shuy reference are discussed together because of the similarity between Xu and Shuy even though they are not the same.

1. Xu and Shuy

Figures 1A, 1B, 2A and 2B of Xu and Shuy are presented below as Figures 11-14.

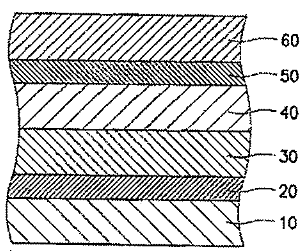


Figure 11
(Figure 1A of Xu/Shuy)

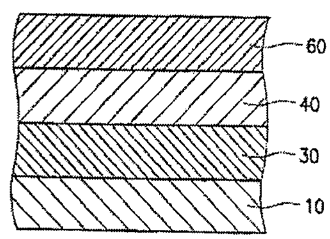
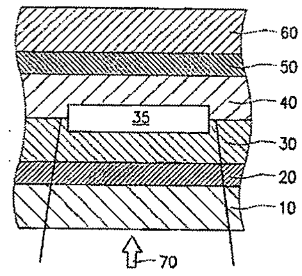


Figure 12
(Figure 1B of Xu/Shuy)



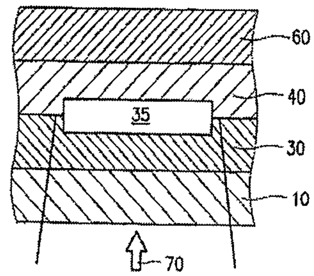


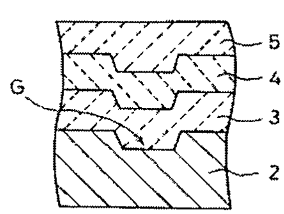
Figure 13 *(Figure 2A of Xu/Shuy)*

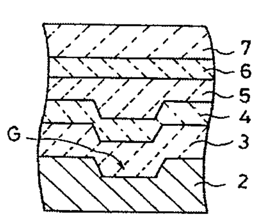
Figure 14 *(Figure 2B of Xu/Shuy)*

Xu and Shuy disclose an optical recording medium having a substrate 10, an optional thermal manipulating layer 20, a transparent layer 30, a reflecting layer 40, another optional thermal manipulating layer 50 and a protective layer 60 as shown in Figures 11 and 12. The transparent layer 30 and the reflecting layer 40 react to form a semi-transparent reflective area (recorded mark) 35 when heated by a light beam 70 through the substrate 10 as shown in Figures 13 and 14 (*see* paragraph 0028 of Shuy). The transparent layer 30 of Xu and Shuy is selected from a group of materials consisting of Si, Ge, GaP, InP, GaAs, InAs, GaSb, InSb, In-Sn oxide, tin oxide, indium oxide, zinc oxide, titanium oxide, Sb-Sn oxide and/or combinations thereof (*see* paragraph 0026 of Shuy). The reflecting layer 40 of Xu and Shuy is selected from a group of materials consisting of Ag, Al, Au, Pt, Cu, In, Sn, W, Ir, Re, Rh, Ta, alloys and/or combinations thereof (*see* paragraph 0027 of Shuy). In the five examples/embodiments disclosed in Xu and Shuy, the reflecting layer 40 is either gold silicon (Au-Si) alloy or tin (Sn) (*see* paragraphs 0033, 0037, 0040, 0045 and 0051 of Shuy).

2. Suzuki

Figures 1, 3 and 4 of Suzuki are presented below as Figures 15-17.





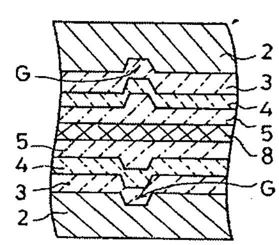


Figure 15 *(Figure 1 of Suzuki)*

Figure 16 *(Figure 3 of Suzuki)*

Figure 17 *(Figure 4 of Suzuki)*

Suzuki discloses an optical recording medium having at least a substrate 2, a first recording layer 3, a second recording layer 4 and a protective layer 5 as shown in Figures 15, 16 and 17. The first recording layer 3 is constructed of a metal such as In, Sn, Pb and Zn, or a metal-metal alloy such as Sn-b, In-Sn, Sn-Ag, In-Si, or Sn-Pb-Si alloy (col. 6, lines 1-16). The second recording layer 4 is constructed of a material which incorporates at least one element from either group 5B or group 6B of the periodic table if the first recording layer 3 contains In as the primary component, and that in the case where the second recording layer 4 is constructed entirely of one of the aforementioned elements, As, Se, Sb, Te and Bi are preferable (col. 6, line 59-col. 7, line 35). A single dielectric layer and/or a light reflection layer, or a plurality of such layers, between the second recording layer 4 and the protective layer 5 may be provided (col. 10, lines 53-61).

3. Yoshida

Figure 1 of Yoshida is presented below as Figures 18.

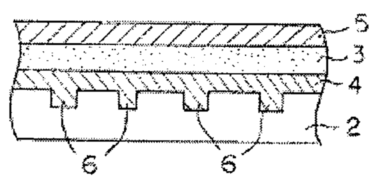


Figure 18
(Figure 1 of Yoshida)

Yoshida is directed to providing a reflection film having high reflectivity and excellent corrosion resistance in an optical recording medium (Abstract). In particular, Yoshida discloses a compact disk CD-R 1 which has a dyestuff film 4 as a recording layer laminated on top of a substrate 2, a reflection film 3 laminated on top of the dyestuff film 4, and a protective film 5 laminated on top of the reflection film 3 as shown in Figure 18 (Abstract). The reflection film 3, not part of the recording layer, is formed of a thin film having a composition of 70 to 90 atomic % of Cu and 1 to 30 atomic % of Al to improve corrosion resistance, and preferably contains 0.1 to 10 atomic % of at least one kind of the elements selected from Fe, Ni and Mn to further improve corrosion resistance (Abstract and paragraphs 0017-0018).

Apparently, the principle of operation employed in Yoshida is totally different from those employed by Xu or Shuy and Suzuki. In Yoshida, data recording is rendered by chemical change of the dye in the dyestuff film 4 to cause changes in an optical characteristic. There is no mixing of two different layers to form a semi-transparent reflective area as a record mark. Namely, the reflection film 3 is not mixed with the dyestuff film 4 by a laser beam for data recording. The chemical change that results in changes in an optical characteristic occurs only in one layer, the dyestuff film 4, and does not involve two different layers or the reflection film 3. Although Yoshida teaches a reflective film, the reflection film 3, having a composition of 70 to 90 atomic % of Cu and 1 to 30 atomic % of Al, the reflection film 3 is nevertheless not a part of the recording layer, which consists of only the dyestuff film 4.

4. <u>Aratani</u>

Figures 1, 2 and 3 of Aratani are presented below as Figures 19-21.

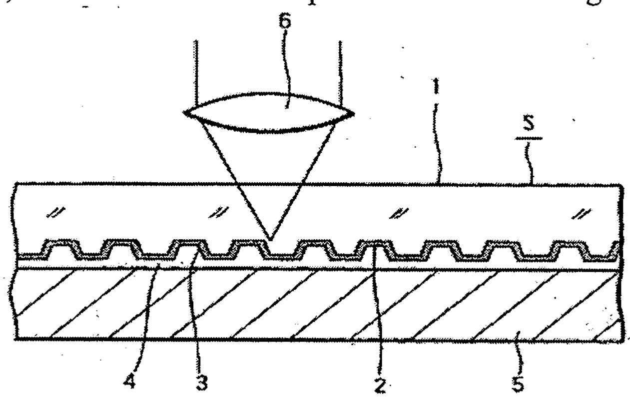


Figure 19
(Figure 1 of Aratani)

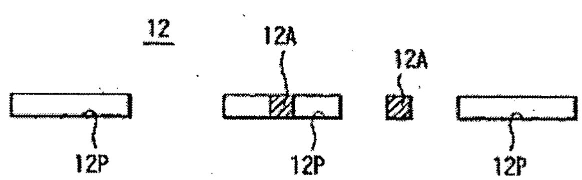


Figure 20
(Figure 2 of Aratani)

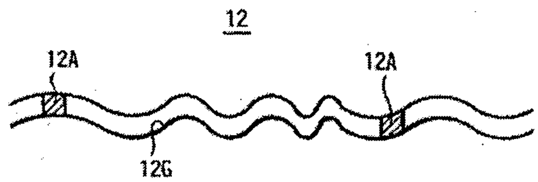


Figure 21
(Figure 3 of Aratani)

Aratani discloses an optical recording medium S that includes a transparent substrate 1, an information layer 2 and a reflective film 3 as shown in Figure 19. The information layer 2 is formed on the transparent substrate 1 and serves as the recording layer on which information is recorded by physical change of shape or uneven pits (paragraph 0034). Information is recorded in recording portions 12 of the information layer 2 as uneven pits 12P or winding guide groove 12G on a major surface of the substrate 1 by injection molding using a stamper having corresponding pits or a corresponding groove (paragraph 0037).

The reflective film 3 is adhered to the entire surface of the information layer 2 (paragraph 0034), and can be made of Cu-alloy film of $Cu_{100-x}X_x$, the X being at least one element selected from Al, Ti, Cr, Ni and Fe, such as $Cu_{82.5}Al_{17.5}$ (paragraph 0044 and Table 2). The reflective film 3 can be used as a recording layer for additional recording (paragraph 0038). More specifically, an additional recording portion 12A can be formed in a pit portion consisting of a recessed portion or a projection portion or between the pits except for the shortest uneven pitch portion of the uneven pits 12P as shown in Figure 20 (paragraph 0039). Alternatively, the additional recording portion 12A can be formed in the winding guide groove 12G as shown in Figure 21 (paragraph 0039).

Apparently, the principle of operation employed in Aratani is totally different from those employed by Xu or Shuy and Suzuki. In Aratani, data recording is rendered by injection molding using a stamper to create uneven pits 12P or winding groove 12G in recording portions 12 of the information layer 2. There is no mixing of two different layers to form a semi-transparent reflective area as a record mark. Namely, the reflective film 3 is not mixed with the information layer 2 by a laser beam for data recording. Although Aratani teaches the reflective film 3 can be made of Cu-alloy film such as $Cu_{82.5}Al_{17.5}$, there is no disclosure that the

information layer 2 contains an element selected from the group consisting of Si, Ge, Sn, Mg, In, Zn, Bi and Al as a primary component such that the primary component of the information layer 2 reacts with the primary component of the reflective film 3 upon irradiation with a laser or light beam to form a mixed region for data recording.

5. Morimoto

Figure 12 of Morimoto is presented below as Figures 22.

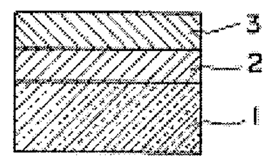


Figure 22
(Figure 12 of Morimoto)

Morimoto discloses a recording medium comprising a substrate 1, a recording layer 2 and a reflective layer 3 as shown in Figure 22. When an energy beam for information recording and readout of the recorded information is irradiated from the side of the substrate 1, the reflective layer 3 is provided on the side of the recording layer 2 remote from the substrate 1, and when the energy beam is irradiated from the side remote from the substrate, the reflective layer is provided between the recording layer 2 and the substrate 1 (col. 6, lines 57-65).

6. Shigeta

Figure 1 of Shigeta is presented below as Figures 23.

Figure 23
(Figure 1 of Shigeta)

Shigeta discloses an optical recording medium on which information is recorded by irradiating a laser beam or other energy rays to deform or remove the positions of the recording layer irradiated by means of melting or the like (page 2 of the English translation). The optical recording medium includes a composite layer 1, a semiconductor layer 2 and a base

plate 3 as shown in Figure 23 (page 4). The recording layer includes the composite layer 1 and the semiconductor layer 2 (page 10). In recording information, heat absorbed from an energy ray melts the composite layer 1 and the melted portion of the composite layer 1 together with the portion of the semiconductor layer 2 contacting it moves, forming bits with changed optical properties to record information (pages 4-5). The composite layer 1 is composed of a metal oxide and fine grains of metal or semiconductor (pages 10-11). In one example the composite layer 1 is composed of Cu and SnO_2 (sample no. 2-11 in Table 2), while in another example the composite layer 1 is composed of Sn andAl_2O_3 (sample no. 2-4 in Table 2).

7. <u>Kinoshita</u>

Figure 1 of Kinoshita is presented below as Figures 24.

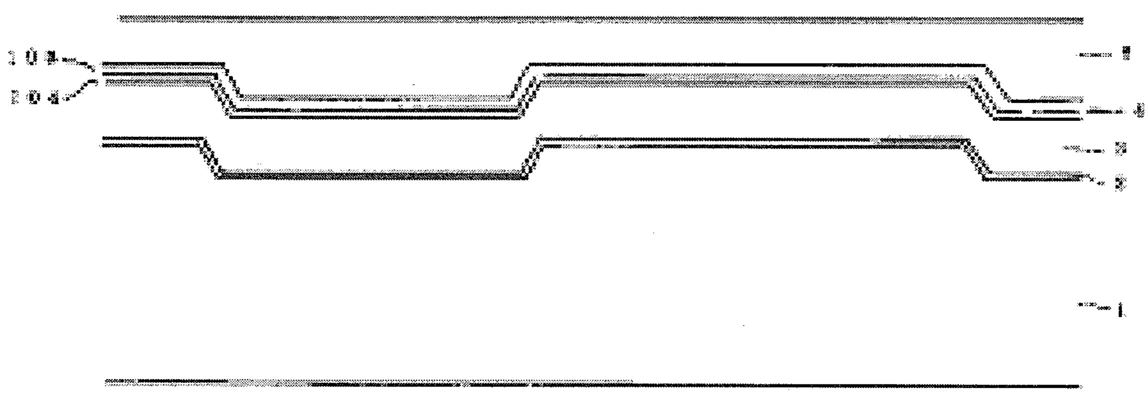


Figure 24
(Figure 1 of Kinoshita)

Kinoshita discloses an optical recording medium that includes a light absorption layer 2, a light interference layer 3, a recording layer 4 comprising a first recording layer 104 and a second recording layer 105 and an environmental protection layer 5 as shown in Figure 24. The light absorption layer 2 consists of Au or Al, and the light interference layer 3 consists of ZnS-SiO_2 or SiO_2 (paragraph 0015). The first recording layer 104 is Au, Ag, Cu, aluminum, etc., and the second recording layer 105 comprises germanium (paragraph 0015).

B. Rejection of Claims 1-25 under 35 U.S.C. § 103(a) over the Art of Record is in Error.

Appellants respectfully submit that the Examiner has failed, among other things, to establish a *prima facie* case of obviousness. The Examiner initially bears the burden of establishing a *prima facie* case of obviousness. *In re Bell*, 26 U.S.P.Q.2d 1529 (Fed. Cir. 1993); *In re Oetiker*, 977 F.2d 1443, 1445, 24 U.S.P.Q.2d 1443, 1444 (Fed. Cir. 1992); *In re Piasecki*, 745 F.2d 1468, 1472, 223 U.S.P.Q. 785, 788 (1984); MPEP § 2142. Under 35 U.S.C. § 103, an Examiner must ask whether the improvement is more than the predictable use of prior art elements according to their established functions." *KSR Intern. Co. v. Teleflex Inc.*, 127 S.Ct. 1727, 1740, 82 U.S.P.Q.2d 1385 (2007). An Applicant may attack an obviousness rejection by showing that the Examiner has failed to properly establish a *prima facie* case or by presenting evidence tending to support a conclusion of non-obviousness. *In re Fritch*, 972 F.2d 1260, 1265, 23 U.S.P.Q.2d 1780 (1992).

As will now be discussed, the Examiner has failed to establish a *prima facie* case of obviousness because even if combined, and they are not, the cited references fail to disclose a combination of the limitations recited in each of the claims. There is no apparent reason to combine the art of record in the manner proposed by the Examiner. There is no suggestion or motivation to one of ordinary skill in the art to modify Xu or Shuy with at least either of Yoshida or Aratani and Suzuki to derive the claimed subject matter as recited in the claims, as the proposed modification would change the principle of operation of Xu or Shuy as well as render Xu or Shuy unsatisfactory for its intended purpose. Further, there is no reasonable expectation of success because there is no suggestion or motivation to combine the cited references and because the cited references, even combined, fail to disclose all the limitations of each claim.

1. Even if Combined, and They Are Not, the Cited References Fail to Show a Combination of the Claimed Limitations for Each Claim.

In order to establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art. *See, e.g.*, *In re Royka*, 490 F.2d 981, 180 USPQ 580 (CCPA 1974). "All words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970). *See also* M.P.E.P. § 2143.03. In determining the differences between the prior

art and the claims, the question under 35 U.S.C. 103 is not whether the differences themselves would have been obvious, but whether the claimed invention as a whole would have been obvious. *Stratoflex, Inc. v. Aeroquip Corp.*, 713 F.2d 1530, 218 USPQ 698 (1983). See also M.P.E.P. § 2141.02.

Since Appellants believe that claims 20 and 22 are patentable for reasons beyond the patentability of claim 1 and 11, respectively, claims 20 and 22 will be separately presented. Claims 2-10 stand or fall with claim 1. Claims 12-19 stand or fall with claim 11. Claim 21 stands or falls with claim 20. Claim 23 stands or falls with claim 22. Claim 25 stands or falls with claim 24.

a) Claims 1-10

The rejection of claims 1-10 does not meet these requirements for *prima facie* obviousness because the cited references, whether individually or in combination, do not teach or suggest all of the claimed limitations of independent claim 1.

Independent claim 1 recites, *inter alia*, an optical recording medium having "at least one recording layer positioned between the reflective layer and the light transmission layer...the recording layer including a first recording film containing an element selected from the group consisting of Si, Ge, Sn, Mg, In, Zn, Bi and Al as a primary component and a second recording film containing Cu as a primary component and 10 to 30 atomic % of Al as an additive, wherein the element contained in the first recording film as a primary component and the element contained in the second recording film as a primary component are mixed upon irradiation with the laser beam." Such an arrangement is not disclosed, taught or suggested by the combination of Xu or Shuy, Suzuki, Morimoto, Shigeta, Kinoshita and either Yoshida or Aratani.

Xu or Shuy records data by irradiating the transparent layer 30 and the reflecting layer 40 with a light beam to form a semi-transparent reflective area as the recorded mark. In particular, Xu or Shuy discloses that the transparent layer 30 is selected from a group of materials consisting of Si, Ge, GaP, InP, GaAs, InAs, GaSb, InSb, In-Sn oxide, tin oxide, indium oxide, zinc oxide, titanium oxide, Sb-Sn oxide and/or combinations thereof, and that the reflecting layer 40 is selected from a group of materials consisting of Ag, Al, Au, Pt, Cu, In, Sn,

W, Ir, Re, Rh, Ta, alloys and/or combinations thereof. Thus, even if the transparent layer 30 and the reflecting layer 40 could somehow be considered analogous to the first recording film and the second recording film of the at least one recording layer as recited in independent claim 1, Xu or Shuy does not disclose, teach or suggest a second recording film containing Cu as a primary component and 10 to 30 atomic % of Al as an additive that reacts with Si or Ge contained in a first recording film as a primary component upon irradiation with a laser or light beam to form a semi-transparent reflective area (mixed region).

The secondary references do not remedy such deficiencies as none of Suzuki, Yoshida, Aratani, Morimoto, Shigeta and Kinoshita discloses, teaches or suggests a recording film containing Cu as a primary component and 10 to 30 atomic % of Al as an additive that reacts with Si or Ge contained in another recording film as a primary component upon irradiation with a laser or light beam to form a semi-transparent reflective area (mixed region). Therefore, even if the teachings of the secondary references were combined with Xu or Shuy, the combination would still fail to disclose, teach or suggest an optical recording medium that includes a recording film containing Cu as a primary component and 10 to 30 atomic % of Al as an additive that reacts with Si or Ge contained in another recording film as a primary component upon irradiation with a laser or light beam to form a semi-transparent reflective area (mixed region).

Suzuki fails to make up for such deficiencies of Xu or Shuy. Suzuki discloses an optical recording medium that includes a first recording layer 3 constructed of a metal such as In, Sn, Pb and Zn, or a metal-metal alloy such as Sn-b, In-Sn, Sn-Ag, In-Si, or Sn-Pb-Si alloy (col. 6, lines 1-16), and a second recording layer 4 constructed of a material which incorporates at least one element from either group 5B or group 6B of the periodic table if the first recording layer 3 contains In as the primary component. There is no teaching or suggestion in Suzuki that either the first recording layer 3 or the second recording layer 4 contains Cu as the primary component with 10 to 30 atomic % of Al as an additive. Besides, there is also no disclosure, teaching or suggestion in Suzuki that the element contained in the first recording film as a primary component and the element contained in the second recording film as a primary component are mixed upon irradiation with the laser beam. Therefore, Suzuki fails to disclose, teach or suggest an optical recording medium that includes a recording film containing Cu as a

primary component and 10 to 30 atomic % of Al as an additive that reacts with Si or Ge contained in another recording film as a primary component upon irradiation with a laser or light beam to form a semi-transparent reflective area (mixed region).

Yoshida fails to make up for the deficiencies of Xu or Shuy and Suzuki for at least the following reasons. In Yoshida, data recording is rendered by chemical change of the dye in the dyestuff film 4 to cause changes in an optical characteristic. There is no mixing of two different layers to form a semi-transparent reflective area as a record mark. Namely, the reflection film 3 is not mixed with the dyestuff film 4 by a laser beam for data recording. The chemical change that results in changes in an optical characteristic occurs only in one layer, the dyestuff film 4, and does not involve a different layer such as the reflection film 3. Although Yoshida teaches a reflective film (i.e., the reflection film 3) having a composition of 70 to 90 atomic % of Cu and 1 to 30 atomic % of Al, the reflection film 3 is nevertheless *not* a part of the recording layer, which consists of *only* the dyestuff film 4. Moreover, there is no disclosure, teaching or suggestion in Yoshida that the element contained in the first recording film as a primary component and the element contained in the second recording film as a primary component are mixed upon irradiation with the laser beam. There is simply no mixing of the element contained in the dyestuff film 4 as a primary component and the element contained in the reflection film 3 as a primary component with a laser beam. Therefore, Yoshida fails to disclose, teach or suggest an optical recording medium that includes a recording film containing Cu as a primary component and 10 to 30 atomic % of Al as an additive that reacts with Si or Ge contained in another recording film as a primary component upon irradiation with a laser or light beam to form a semi-transparent reflective area (mixed region).

Aratani fails to make up for the deficiencies of Xu, Shuy, Suzuki and Yoshida for at least the following reasons. In Aratani, data recording is rendered by injection molding using a stamper to create uneven pits 12P or winding groove 12G in recording portions 12 of the information layer 2. There is no mixing of two different layers to form a semi-transparent reflective area as a record mark. Namely, the reflective film 3 is not mixed with the information layer 2 by a laser beam for data recording. Although Aratani teaches the reflective film 3 can be made of Cu-alloy film such as $Cu_{82.5}Al_{17.5}$, there is no disclosure that the information layer 2 contains an element selected from the group consisting of Si, Ge, Sn, Mg, In, Zn, Bi and Al as a

primary component such that the primary component of the information layer 2 reacts with the primary component of the reflective film 3 upon irradiation with a laser or light beam to form a mixed region for data recording. At this point, Appellants respectfully submit the reminder that, in determining the differences between the prior art and the claims, the question under 35 U.S.C. § 103 is not whether the differences themselves would have been obvious, but *whether the claimed invention as a whole would have been obvious*. See M.P.E.P. § 2141.02. Therefore, Aratani fails to disclose, teach or suggest an optical recording medium that includes a recording film containing Cu as a primary component and 10 to 30 atomic % of Al as an additive that reacts with Si or Ge contained in another recording film as a primary component upon irradiation with a laser or light beam to form a semi-transparent reflective area (mixed region).

Each of Morimoto, Shigeta and Kinoshita fails to make up for the deficiencies of Xu, Shuy, Suzuki, Yoshida and Aratani for at least the reason that none of Morimoto, Shigeta and Kinoshita discloses, teaches or suggests a second recording film containing Cu as the primary component with 10 to 30 atomic % of Al as an additive. Further, none of Morimoto, Shigeta and Kinoshita discloses, teaches or suggests wherein the element contained in the first recording film as a primary component and the element contained in the second recording film as a primary component are mixed upon irradiation with the laser beam. Therefore, each of Morimoto, Shigeta and Kinoshita fails to disclose, teach or suggest an optical recording medium that includes a recording film containing Cu as a primary component and 10 to 30 atomic % of Al as an additive that reacts with Si or Ge contained in another recording film as a primary component upon irradiation with a laser or light beam to form a semi-transparent reflective area (mixed region).

Therefore, the Examiner has failed to establish a *prima facie* case of obviousness as the cited references, whether individually or in combination, do not teach or suggest all of the claimed limitations of independent claim 1.

b) Claims 11-19

The rejection of claims 11-19 does not meet these requirements for *prima facie* obviousness because the cited references, whether individually or in combination, do not teach or suggest all of the claimed limitations of independent claim 11.

Independent claim 11 recites, *inter alia*, an optical recording medium having "a plurality of information record layers positioned between the reflective layer and the light transmission layer, the recording being of the type in which data can be recorded by projecting a laser beam thereonto via the light transmission layer, at least one information recording layer other than an information recording layer farthest from a light incidence plane through which a laser beam enters including a first recording film containing an element selected from the group consisting of Si, Ge, Sn, Mg, In, Zn, Bi and Al as a primary component and a second recording film containing Cu as a primary component and 10 to 30 atomic % of Al as an additive, wherein the element contained in the first recording film as a primary component and the element contained in the second recording film as a primary component are mixed upon irradiation with the laser beam." Such an arrangement is not disclosed, taught or suggested by the combination of Xu or Shuy, Suzuki, Morimoto, Shigeta, Kinoshita and either Yoshida or Aratani.

Xu or Shuy records data by irradiating the transparent layer 30 and the reflecting layer 40 with a light beam to form a semi-transparent reflective area as the recorded mark. In particular, Xu or Shuy discloses that the transparent layer 30 is selected from a group of materials consisting of Si, Ge, GaP, InP, GaAs, InAs, GaSb, InSb, In-Sn oxide, tin oxide, indium oxide, zinc oxide, titanium oxide, Sb-Sn oxide and/or combinations thereof, and that the reflecting layer 40 is selected from a group of materials consisting of Ag, Al, Au, Pt, Cu, In, Sn, W, Ir, Re, Rh, Ta, alloys and/or combinations thereof. Thus, even if the transparent layer 30 and the reflecting layer 40 could somehow be considered analogous to the first recording film and the second recording film of the at least one recording layer as recited in independent claim 11, Xu or Shuy does not disclose, teach or suggest a second recording film containing Cu as a primary component and 10 to 30 atomic % of Al as an additive that reacts with Si or Ge contained in a first recording film as a primary component upon irradiation with a laser or light beam to form a semi-transparent reflective area (mixed region). Additionally, there is no disclosure, teaching or suggestion in Su or Shuy of at least one information recording layer other than an information recording layer farthest from a light incidence plane through which a laser beam enters including a first recording film containing an element selected from the group consisting of Si, Ge, Sn, Mg, In, Zn, Bi and Al as a primary component and a second recording film containing Cu as a primary component and 10 to 30 atomic % of Al as an additive.

The secondary references do not remedy such deficiencies as Suzuki, Yoshida, Aratani, Morimoto, Shigeta and Kinoshita fails to at least disclose, teach or suggest a recording film containing Cu as a primary component and 10 to 30 atomic % of Al as an additive that reacts with Si or Ge contained in another recording film as a primary component upon irradiation with a laser or light beam to form a semi-transparent reflective area (mixed region). Besides, none of as Suzuki, Yoshida, Aratani, Morimoto, Shigeta and Kinoshita discloses, teaches or suggests at least one information recording layer other than an information recording layer farthest from a light incidence plane through which a laser beam enters including a first recording film containing an element selected from the group consisting of Si, Ge, Sn, Mg, In, Zn, Bi and Al as a primary component and a second recording film containing Cu as a primary component and 10 to 30 atomic % of Al as an additive. Therefore, even if the teachings of the secondary references were combined with Xu or Shuy, the combination would still fail to disclose, teach or suggest an optical recording medium that includes a recording film containing Cu as a primary component and 10 to 30 atomic % of Al as an additive that reacts with Si or Ge contained in another recording film as a primary component upon irradiation with a laser or light beam to form a semi-transparent reflective area (mixed region).

Suzuki fails to make up for such deficiencies of Xu or Shuy. Suzuki discloses an optical recording medium that includes a first recording layer 3 constructed of a metal such as In, Sn, Pb and Zn, or a metal-metal alloy such as Sn-b, In-Sn, Sn-Ag, In-Si, or Sn-Pb-Si alloy (col. 6, lines 1-16), and a second recording layer 4 constructed of a material which incorporates at least one element from either group 5B or group 6B of the periodic table if the first recording layer 3 contains In as the primary component. There is no teaching or suggestion in Suzuki that either the first recording layer 3 or the second recording layer 4 contains Cu as the primary component with 10 to 30 atomic % of Al as an additive. Besides, there is also no disclosure, teaching or suggestion in Suzuki that the element contained in the first recording film as a primary component and the element contained in the second recording film as a primary component are mixed upon irradiation with the laser beam. Therefore, Suzuki fails to disclose, teach or suggest an optical recording medium that includes a recording film containing Cu as a primary component and 10 to 30 atomic % of Al as an additive that reacts with Si or Ge

contained in another recording film as a primary component upon irradiation with a laser or light beam to form a semi-transparent reflective area (mixed region).

Yoshida fails to make up for the deficiencies of Xu or Shuy and Suzuki for at least the following reasons. In Yoshida, data recording is rendered by chemical change of the dye in the dyestuff film 4 to cause changes in an optical characteristic. There is no mixing of two different layers to form a semi-transparent reflective area as a record mark. Namely, the reflection film 3 is not mixed with the dyestuff film 4 by a laser beam for data recording. The chemical change that results in changes in an optical characteristic occurs only in one layer, the dyestuff film 4, and does not involve a different layer such as the reflection film 3. Although Yoshida teaches a reflective film (i.e., the reflection film 3) having a composition of 70 to 90 atomic % of Cu and 1 to 30 atomic % of Al, the reflection film 3 is nevertheless *not* a part of the recording layer, which consists of *only* the dyestuff film 4. Moreover, there is no disclosure, teaching or suggestion in Yoshida that the element contained in the first recording film as a primary component and the element contained in the second recording film as a primary component are mixed upon irradiation with the laser beam. There is simply no mixing of the element contained in the dyestuff film 4 as a primary component and the element contained in the reflection film 3 as a primary component with a laser beam. Therefore, Yoshida fails to disclose, teach or suggest an optical recording medium that includes a recording film containing Cu as a primary component and 10 to 30 atomic % of Al as an additive that reacts with Si or Ge contained in another recording film as a primary component upon irradiation with a laser or light beam to form a semi-transparent reflective area (mixed region).

Aratani fails to make up for the deficiencies of Xu, Shuy, Suzuki and Yoshida for at least the following reasons.. In Aratani, data recording is rendered by injection molding using a stamper to create uneven pits 12P or winding groove 12G in recording portions 12 of the information layer 2. There is no mixing of two different layers to form a semi-transparent reflective area as a record mark. Namely, the reflective film 3 is not mixed with the information layer 2 by a laser beam for data recording. Although Aratani teaches the reflective film 3 can be made of Cu-alloy film such as $Cu_{82.5}Al_{17.5}$, there is no disclosure that the information layer 2 contains an element selected from the group consisting of Si, Ge, Sn, Mg, In, Zn, Bi and Al as a primary component such that the primary component of the information layer 2 reacts with the

primary component of the reflective film 3 upon irradiation with a laser or light beam to form a mixed region for data recording. Therefore, Aratani fails to disclose, teach or suggest an optical recording medium that includes a recording film containing Cu as a primary component and 10 to 30 atomic % of Al as an additive that reacts with Si or Ge contained in another recording film as a primary component upon irradiation with a laser or light beam to form a semi-transparent reflective area (mixed region).

Each of Morimoto, Shigeta and Kinoshita fails to make up for the deficiencies of Xu, Shuy, Suzuki, Yoshida and Aratani for at least the reason that none of Morimoto, Shigeta and Kinoshita discloses, teaches or suggests a second recording film containing Cu as the primary component with 10 to 30 atomic % of Al as an additive. Further, none of Morimoto, Shigeta and Kinoshita discloses, teaches or suggests wherein the element contained in the first recording film as a primary component and the element contained in the second recording film as a primary component are mixed upon irradiation with the laser beam. Therefore, each of Morimoto, Shigeta and Kinoshita fails to disclose, teach or suggest an optical recording medium that includes a recording film containing Cu as a primary component and 10 to 30 atomic % of Al as an additive that reacts with Si or Ge contained in another recording film as a primary component upon irradiation with a laser or light beam to form a semi-transparent reflective area (mixed region).

Therefore, the Examiner has failed to establish a *prima facie* case of obviousness as the cited references, whether individually or in combination, do not teach or suggest all of the claimed limitations of independent claim 11.

c) Claims 20-21

Claim 20 is allowable at least for being dependent from allowable independent claim 1. In addition, claim 20 is patentable on its own merits as will now be discussed. Similarly, claim 21 is allowable at least for being dependent from allowable claim 20 and for its own merits. Appellants reserve the right to separately argue, in subsequent continuing applications, the patentability of various dependent features not addressed herein.

Claim 20 recites, *inter alia*, wherein the difference in the light transmittances of a mixed region of the first recording film and the second recording film and a region where the

first recording film and the second recording film do not mix with each other is equal to or less than 3% for a laser beam having a wavelength of 380 nm to 450 nm. Such an arrangement is not disclosed, taught or suggested by the combination of Xu or Shuy, Suzuki, Morimoto, Shigeta, Kinoshita and either Yoshida or Aratani.

The Examiner takes the position that "[t]he language describing the small transmittance differences fails to appreciate that with the reflective layer, the recording process uses the change in the refractive index of the bilayer areas and the mixed areas as discussed in Suzuki et al. at 7/58-[8]/19 (push-pull). Therefore the change in the transmittance is not relied upon as argued/implied by the applicant and there is no benefit ascribed to this. The examiner notes that at this point the position argued is one of intended use as there are no method claims under prosecution" (Office Action, pages 8-9).

Appellants strongly disagree. The small difference (equal to or less than 3%) in light transmittances as recited is desirable and is important from at least the perspective of the integrity of data reproduced, especially when there are multiple recording layers in the optical recording medium. When an optical recording medium includes at least an upper recording layer and a lower recording layer where the upper recording layer is closer to the light incidence plane through which a laser beam enters the optical recording medium than the lower recording layer is, the amount of light that reaches the lower recording layer or the amount of light that is reflected from the lower recording surface hardly changes whether the light passes through a blank region or a region where a record mark M is formed by mixing Si and Cu.

There is no teaching, suggestion or recognition of such benefit and arrangement in any of the cited references. In particular, there appears to be no recognition of such benefit in Suzuki, and Suzuki does not disclose, teach or suggest the limitations recited in claim 20. Rather, Suzuki teaches away from the concept of small difference in light transmittances by teaching a very different refractive index in a region where a record mark is formed than that of a blank region. To be sure, the passage of Suzuki cited by the Examiner is provided below.

> Furthermore, because the first recording layer 3 constructed from a metal incorporating highly reflective In as a main constituent is located on top of the substrate 2 through which the recording and/or reproduction light is irradiated, a high reflectance is achieved in the state prior to recording.

> The elements from group 5B or 6B of the periodic table which are incorporated into the second recording layer 4 mix or react with the In to form an intermetallic compound or a semiconductor thus reducing the metallic properties of the In. Consequently, *those portions of the medium which have been irradiated with the recording beam and for which the In of the first recording layer 3 has mixed with the second layer 4 appear as a record marked portion with a very different refractive index to that of metallic In*.
>
> In the present invention the above mixing and/or reaction is accompanied by an induced deformation at the interface between the substrate 2 and the first recording layer 3, and/or at the interface between the second recording layer 4 and the protective layer 5, meaning an irregularity or pit is also formed at the record marked portion. The combination of the formation of an alloy with *a different refractive index*, and the formation of irregularities or pitting, means the reflectance at the record marked portion is greatly reduced causing a "high to low" record with a large degree of modulation. Because the formation of the irregularities or pitting utilizes the mixing and/or reaction of the two recording layers, it is possible to achieve improved recording sensitivity or an increased degree of modulation in comparison with current pitted optical recording media which comprise only a single recording layer. (*Suzuki, col. 7, line 58 – col. 8, line 19*) (emphasis added).

Clearly, Suzuki relies on having the record marked region with a very different refractive index than that of metallic In, which constitutes the first recording layer 3, to provide an increased degree of modulation for achieving improved recording sensitivity. As well known in the art, a refractive index of a medium is a measure for how much the speed of light (or other waves such as sound waves) is reduced inside the medium. What Suzuki discloses is large difference between the refractive index of a record marked region and the refractive index of a blank region. This has nothing to do with achieving a small difference between the light transmittance of a region where a record mark is formed by mixing Si and Cu and the light transmittance of a blank region.

Not only the Examiner fails to appreciate the significance of and the benefit ascribed to the small difference in light transmittances recited in claim 20, the Examiner also mischaracterized such desirable property attainable by the arrangement recited in claim 20 as "intended use." As can be seen from previous discussions, having a small difference in light transmittances between a region where a record mark is formed by mixing Si and Cu and a blank region is desirable. It is a characteristic of an optical recording medium structured with a first recording layer having Si as a primary component and a second recording layer having Cu as a

primary component with 10 to 30 atomic % of Al as an additive. Although such characteristic produces optimal results when a laser beam having a wavelength of 380 nm to 450 nm is used, this desirable characteristic does not change and is related to the structure claimed.

None of the other cited references makes up for the deficiencies of Suzuki. Therefore, the Examiner has failed to establish a *prima facie* case of obviousness as the cited references, whether individually or in combination, do not teach or suggest all of the claimed limitations of independent claim 20.

d) Claims 22-23

Claim 22 is allowable at least for being dependent from allowable independent claim 11. In addition, claim 22 is patentable on its own merits as will now be discussed. Similarly, claim 23 is allowable at least for being dependent from allowable claim 22 and for its own merits. Appellants reserve the right to separately argue, in subsequent continuing applications, the patentability of various dependent features not addressed herein.

Claim 22 recites, *inter alia*, wherein the difference in the light transmittances of a mixed region of the first recording film and the second recording film and a region where the first recording film and the second recording film do not mix with each other is equal to or less than 3% for a laser beam having a wavelength of 380 nm to 450 nm. Such an arrangement is not disclosed, taught or suggested by the combination of Xu or Shuy, Suzuki, Morimoto, Shigeta, Kinoshita and either Yoshida or Aratani.

The Examiner takes the position that "[t]he language describing the small transmittance differences fails to appreciate that with the reflective layer, the recording process uses the change in the refractive index of the bilayer areas and the mixed areas as discussed in Suzuki et al. at 7/58-[8]/19 (push-pull). Therefore the change in the transmittance is not relied upon as argued/implied by the applicant and there is no benefit ascribed to this. The examiner notes that at this point the position argued is one of intended use as there are no method claims under prosecution" (Office Action, pages 8-9).

Appellants strongly disagree. The small difference (equal to or less than 3%) in light transmittances as recited is desirable and is important from at least the perspective of the integrity of data reproduced, especially when there are multiple recording layers in the optical

recording medium. When an optical recording medium includes at least an upper recording layer and a lower recording layer where the upper recording layer is closer to the light incidence plane through which a laser beam enters the optical recording medium than the lower recording layer is, the amount of light that reaches the lower recording layer or the amount of light that is reflected from the lower recording surface hardly changes whether the light passes through a blank region or a region where a record mark M is formed by mixing Si and Cu.

There is no teaching, suggestion or recognition of such benefit and arrangement in any of the cited references. In particular, there appears to be no recognition of such benefit in Suzuki, and Suzuki does not disclose, teach or suggest the limitations recited in claim 22. Rather, Suzuki teaches away from the concept of small difference in light transmittances by teaching a very different refractive index in a region where a record mark is formed than that of a blank region. To be sure, the passage of Suzuki cited by the Examiner is provided below.

> Furthermore, because the first recording layer 3 constructed from a metal incorporating highly reflective In as a main constituent is located on top of the substrate 2 through which the recording and/or reproduction light is irradiated, a high reflectance is achieved in the state prior to recording.
>
> The elements from group 5B or 6B of the periodic table which are incorporated into the second recording layer 4 mix or react with the In to form an intermetallic compound or a semiconductor thus reducing the metallic properties of the In. Consequently, *those portions of the medium which have been irradiated with the recording beam and for which the In of the first recording layer 3 has mixed with the second layer 4 appear as <u>a record marked portion with a very different refractive index to that of metallic In</u>*.
>
> In the present invention the above mixing and/or reaction is accompanied by an induced deformation at the interface between the substrate 2 and the first recording layer 3, and/or at the interface between the second recording layer 4 and the protective layer 5, meaning an irregularity or pit is also formed at the record marked portion. The combination of the formation of an alloy with *<u>a different refractive index</u>*, and the formation of irregularities or pitting, means the reflectance at the record marked portion is greatly reduced causing a "high to low" record with a large degree of modulation. Because the formation of the irregularities or pitting utilizes the mixing and/or reaction of the two recording layers, it is possible to achieve improved recording sensitivity or an increased degree of modulation in comparison with current pitted optical recording media which comprise only a single recording layer. (*Suzuki, col. 7, line 58 – col. 8, line 19*) (emphasis added).

Clearly, Suzuki relies on having the record marked region with a very different refractive index than that of metallic In, which constitutes the first recording layer 3, to provide an increased degree of modulation for achieving improved recording sensitivity. As well known in the art, a refractive index of a medium is a measure for how much the speed of light (or other waves such as sound waves) is reduced inside the medium. What Suzuki discloses is large difference between the refractive index of a record marked region and the refractive index of a blank region. This has nothing to do with achieving a small difference between the light transmittance of a region where a record mark is formed by mixing Si and Cu and the light transmittance of a blank region.

Not only the Examiner fails to appreciate the significance of and the benefit ascribed to the small difference in light transmittances recited in claim 22, the Examiner also mischaracterized such desirable property attainable by the arrangement recited in claim 22 as "intended use." As can be seen from previous discussions, having a small difference in light transmittances between a region where a record mark is formed by mixing Si and Cu and a blank region is desirable. It is a characteristic of an optical recording medium structured with a first recording layer having Si as a primary component and a second recording layer having Cu as a primary component with 10 to 30 atomic % of Al as an additive. Although such characteristic produces optimal results when a laser beam having a wavelength of 380 nm to 450 nm is used, this desirable characteristic does not change and is related to the structure claimed.

None of the other cited references makes up for the deficiencies of Suzuki. Therefore, the Examiner has failed to establish a *prima facie* case of obviousness as the cited references, whether individually or in combination, do not teach or suggest all of the claimed limitations of independent claim 22.

e) Claims 24-25

The rejection of claims 24-25 does not meet these requirements for *prima facie* obviousness because the cited references, whether individually or in combination, do not teach or suggest all of the claimed limitations of independent claim 24.

Independent claim 24 recites, *inter alia*, an optical recording medium having "at least one recording layer positioned between the reflective layer and the light transmission layer,

the recording being of the type in which data can be recorded by projecting a laser beam thereonto via the light transmission layer, the recording layer including a first recording film containing an element selected from the group consisting of Si, Ge, Sn, Mg, In, Zn, Bi and Al as a primary component and a second recording film containing Cu as a primary component and 10 to 30 atomic % of Al as an additive, wherein the difference in the light transmittances of a mixed region of the first recording film and the second recording film and a region where the first recording film and the second recording film do not mix with each other is equal to or less than 3% for a laser beam having a wavelength of 380 nm to 450 nm." Such an arrangement is not disclosed, taught or suggested by the combination of Xu or Shuy, Suzuki, Morimoto, Shigeta, Kinoshita and either Yoshida or Aratani.

Xu or Shuy records data by mixing the transparent layer 30 and the reflecting layer 40 to form a semi-transparent reflective area as the recorded mark. However, Xu or Shuy at least fails to disclose, teach or suggest a second recording film containing Cu as a primary component and 10 to 30 atomic % of Al as an additive.

Suzuki fails to make up for such deficiencies as Suzuki at least fails to disclose, teach or suggest that either the first recording layer 3 or the second recording layer 4 contains Cu as the primary component with 10 to 30 atomic % of Al as an additive.

Yoshida fails to make up for the deficiencies of Xu, Shuy and Suzuki for at least the following reasons. The reflection film 3 of Yoshida is not a part of the recording layer, which consists of only the dyestuff film 4. Even though the reflection film 3 of Yoshida has a composition of 70 to 90 atomic % of Cu and 1 to 30 atomic % of Al, Yoshida still fails to disclose a second recording film containing Cu as the primary component with 10 to 30 atomic % of Al as an additive since the reflection film 3 is not a part of the recording layer.

Aratani fails to make up for the deficiencies of Xu, Shuy, Suzuki and Yoshida for at least the following reasons. The information layer 2 does not contain Cu as the primary component with 10 to 30 atomic % of Al as an additive. Although the reflective film 3 can be made of Cu-alloy film of $Cu_{100-x}X_x$, such as $Cu_{82.5}Al_{17.5}$, the reflective film 3 is not mixed with the information layer 2 to form a mixed region as recited by claim 24. In determining the differences between the prior art and the claims, the question under 35 U.S.C. § 103 is not

whether the differences themselves would have been obvious, but *whether the claimed invention as a whole would have been obvious*. See M.P.E.P. § 2141.02.

Each of Morimoto, Shigeta and Kinoshita fails to make up for the deficiencies of Xu, Shuy, Suzuki, Yoshida and Aratani for at least the reason that none of Morimoto, Shigeta and Kinoshita discloses, teaches or suggests a second recording film containing Cu as the primary component with 10 to 30 atomic % of Al as an additive.

With respect to the recited difference in the light transmittances, the Examiner takes the position that "[t]he language describing the small transmittance differences fails to appreciate that with the reflective layer, the recording process uses the change in the refractive index of the bilayer areas and the mixed areas as discussed in Suzuki et al. at 7/58-[8]/19 (push-pull). Therefore the change in the transmittance is not relied upon as argued/implied by the applicant and there is no benefit ascribed to this. The examiner notes that at this point the position argued is one of intended use as there are no method claims under prosecution" (Office Action, pages 8-9).

Appellants strongly disagree. The small difference (equal to or less than 3%) in light transmittances as recited is desirable and is important from at least the perspective of the integrity of data reproduced, especially when there are multiple recording layers in the optical recording medium. When an optical recording medium includes at least an upper recording layer and a lower recording layer where the upper recording layer is closer to the light incidence plane through which a laser beam enters the optical recording medium than the lower recording layer is, the amount of light that reaches the lower recording layer or the amount of light that is reflected from the lower recording surface hardly changes whether the light passes through a blank region or a region where a record mark M is formed by mixing Si and Cu.

There is no teaching, suggestion or recognition of such benefit and arrangement in any of the cited references. In particular, there appears to be no recognition of such benefit in Suzuki, and Suzuki does not disclose, teach or suggest the limitations recited in claim 24. Rather, Suzuki teaches away from the concept of small difference in light transmittances by teaching a very different refractive index in a region where a record mark is formed than that of a blank region. To be sure, the passage of Suzuki cited by the Examiner is provided below.

> Furthermore, because the first recording layer 3 constructed from a metal incorporating highly reflective In as a main constituent is located on top of the substrate 2 through which the recording and/or reproduction light is irradiated, a high reflectance is achieved in the state prior to recording.
>
> The elements from group 5B or 6B of the periodic table which are incorporated into the second recording layer 4 mix or react with the In to form an intermetallic compound or a semiconductor thus reducing the metallic properties of the In. Consequently, *those portions of the medium which have been irradiated with the recording beam and for which the In of the first recording layer 3 has mixed with the second layer 4 appear as a record marked portion with a very different refractive index to that of metallic In*.
>
> In the present invention the above mixing and/or reaction is accompanied by an induced deformation at the interface between the substrate 2 and the first recording layer 3, and/or at the interface between the second recording layer 4 and the protective layer 5, meaning an irregularity or pit is also formed at the record marked portion. The combination of the formation of an alloy with *a different refractive index*, and the formation of irregularities or pitting, means the reflectance at the record marked portion is greatly reduced causing a "high to low" record with a large degree of modulation. Because the formation of the irregularities or pitting utilizes the mixing and/or reaction of the two recording layers, it is possible to achieve improved recording sensitivity or an increased degree of modulation in comparison with current pitted optical recording media which comprise only a single recording layer. (*Suzuki, col. 7, line 58 – col. 8, line 19*) (emphasis added).

Clearly, Suzuki relies on having the record marked region with a very different refractive index than that of metallic In, which constitutes the first recording layer 3, to provide an increased degree of modulation for achieving improved recording sensitivity. As well known in the art, a refractive index of a medium is a measure for how much the speed of light (or other waves such as sound waves) is reduced inside the medium. What Suzuki discloses is large difference between the refractive index of a record marked region and the refractive index of a blank region. This has nothing to do with achieving a small difference between the light transmittance of a region where a record mark is formed by mixing Si and Cu and the light transmittance of a blank region.

Not only the Examiner fails to appreciate the significance of and the benefit ascribed to the small difference in light transmittances recited in claim 24, the Examiner also mischaracterized such desirable property attainable by the arrangement recited in claim 24 as "intended use." As can be seen from previous discussions, having a small difference in light transmittances between a region where a record mark is formed by mixing Si and Cu and a blank

region is desirable. It is a characteristic of an optical recording medium structured with a first recording layer having Si as a primary component and a second recording layer having Cu as a primary component with 10 to 30 atomic % of Al as an additive. Although such characteristic produces optimal results when a laser beam having a wavelength of 380 nm to 450 nm is used, this desirable characteristic does not change and is related to the structure claimed.

None of the other cited references makes up for the deficiencies of Suzuki.

Therefore, the Examiner has failed to establish a *prima facie* case of obviousness as the cited references, whether individually or in combination, do not teach or suggest all of the claimed limitations of independent claim 24.

2. There is No Apparent Reason, Suggestion or Motivation to Modify Xu or Shuy with Suzuki, Yoshida, Aratani, Morimoto, Shigeta and Kinoshita.

There is no apparent reason, suggestion or motivation to combine the teachings of Suzuki, Yoshida, Aratani, Morimoto, Shigeta and Kinoshita with the optical recording medium disclosed by Xu or Shuy for at least the following two reasons.

Firstly, as discussed above, Xu and Shuy discloses recording data by irradiating the transparent layer 30 and the reflecting layer 40 with a light beam to form a semi-transparent reflective area as the recorded mark, where the element contained in the transparent layer 30 as a primary component and the element contained in the reflecting layer 40 as a primary component are mixed upon irradiation with the light beam. In contrast, none of the secondary references discloses, teaches or suggests that the element contained in a first recording film as a primary component and the element contained in a second recording film as a primary component are mixed upon irradiation with a laser or light beam. Thus, an ordinary person skilled in the art cannot be motivated to combine the teachings of Suzuki, Yoshida, Aratani, Morimoto, Shigeta and Kinoshita with the optical recording medium disclosed by Xu or Shuy.

Secondly, the Supreme Court recently stated, "often it will be necessary for a court to look to interrelated teachings of multiple patents; the effects of demands known to the design community or present in the market place; and the background knowledge possessed by a person having ordinary skill in the art, all in order to determine *whether there was an apparent*

reason to combine the known elements in the fashion claimed by the patent at issue. *KSR Int'l Co. v. Teleflex Inc., et al.*, 127 S.Ct. 1727, 1740-1741 (2007) (emphasis added).

The claims at issue here include not only the listed features, but also recite a particular arrangement (*e.g.*, structural and functional interrelationship limitations) among the features that is not taught or suggested, either implicitly or explicitly, by the art of record.

For example, claim 1 recites, *inter alia*, a particular interrelationship between the first recording film 31 containing an element selected from the group consisting of Si, Ge, Sn, Mg, In, Zn, Bi and Al as a primary component and the second recording film 32 containing Cu as a primary component and 10 to 30 atomic % of Al as an additive, in that the element contained in the first recording film 31 (*e.g.*, Si) as a primary component and the element contained in the second recording film 32 as a primary component (*e.g.*, Cu) are mixed upon irradiation with the laser beam L. None of the cited references mentions or recognizes such an interrelationship as important.

Claim 11 recites, *inter alia*, a particular interrelationship between the information recording layer 60 and the information recording layer 50. The recited information recording layer 60, being the recording layer other than the recording layer farthest from a light incidence plane 43a through which a laser beam L enters (*i.e.*, the information recording layer 50), includes the first recording film 63 containing an element selected from the group consisting of Si, Ge, Sn, Mg, In, Zn, Bi and Al as a primary component the second recording film 62 containing Cu as a primary component and 10 to 30 atomic % of Al as an additive. The element contained in the first recording film 63 as a primary component (*e.g.*, Si) and the element contained in the second recording film 62 as a primary component (*e.g.*, Cu) are mixed upon irradiation with the laser beam L. None of the cited references mentions or recognizes such an interrelationship as important.

Claim 20 recites, *inter alia*, a particular interrelationship between a mixed region of the first recording film 31 and the second recording film 32 and a region where the first recording film 31 and the second recording film 32 do not mix with each other. In particular, the recited difference in the light transmittances of the mixed region of the first recording film 31 and the second recording film 32 and a region where the first recording film 31 and the second recording film 32 do not mix with each other is equal to or less than 3% for a laser beam L

having a wavelength of 380 nm to 450 nm. None of the cited references mentions or recognizes such an interrelationship as important.

Claim 22 recites, *inter alia*, a particular interrelationship between a mixed region of the first recording film 31 and the second recording film 32 and a region where the first recording film 31 and the second recording film 32 do not mix with each other. In particular, the recited difference in the light transmittances of the mixed region of the first recording film 31 and the second recording film 32 and a region where the first recording film 31 and the second recording film 32 do not mix with each other is equal to or less than 3% for a laser beam L having a wavelength of 380 nm to 450 nm. None of the cited references mentions or recognizes such an interrelationship as important.

Claim 24 recites, *inter alia*, a particular interrelationship for the recording layer 14 as well as a particular arrangement between a mixed region of the first recording film 31 and the second recording film 32 and a region where the first recording film 31 and the second recording film 32 do not mix with each other. The recited recording layer 14 includes the first recording film 31 containing an element selected from the group consisting of Si, Ge, Sn, Mg, In, Zn, Bi and Al as a primary component and a second recording film 32 containing Cu as a primary component and 10 to 30 atomic % of Al as an additive. Moreover, the recited difference in the light transmittances of the mixed region of the first recording film 31 and the second recording film 32 and a region where the first recording film 31 and the second recording film 32 do not mix with each other is equal to or less than 3% for a laser beam L having a wavelength of 380 nm to 450 nm. None of the cited references mentions or recognizes such an interrelationship as important.

As the foregoing showed, Xu or Shuy does not mention, recognize, teach, or suggest implicitly or explicitly the particular interrelationship recited in each of claims 1, 11, 20, 22 and 24. None of the other cited references teaches or suggests the particular interrelationship recited in each of claims 1, 11, 20, 22 and 24. Therefore, there is no apparent reason to combine the cited references.

3. There is No Suggestion or Motivation to Modify Xu or Shuy with Either of Yoshida or Aratani as the Proposed Modification Would Change the Principle of Operation of Xu or Shuy.

The mere fact that references can be combined or modified does not render the resultant combination obvious unless the results would have been predictable to one of ordinary skill in the art. *KSR International Co. v. Teleflex Inc.*, 127 S.Ct. 1727, 1741, 82 USPQ2d 1385, 1396 (2007). *See also* M.P.E.P. § 2143.01. If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims prima facie obvious. *In re Ratti*, 270 F.2d 810, 123 USPQ 349 (1959).

The Examiner relies upon either Xu or Shuy and either of Yoshida or Aratani to show the claimed second recording film that contains Cu as a primary component and 10 to 30 atomic % of Al as an additive. In particular, the Examiner asserts that it would have been obvious to one skilled in the art "to modify the examples corresponding to figure 1A of either Xu et al. CN 1330368 or Shuy et al. '160 by using Cu alloys with less than 10-30% of Al, such as those disclosed by either of Yoshida et al. JP 10-143919 or Aratani et al. EP 1122723 in place of the Au layer with a reasonable expectation of forming a useful alloying optical recording medium based upon the disclosure of equivalence of the reflective layer materials including Cu alloys by either Xu et al. CN 1330368 or Shuy et al. '160, where the Cu layer does not suffer from corrosion based upon the teachings of either of Yoshida et al. JP 10-143919 or Aratani et al. EP 1122723 and to add a reflective layer between layers 50 and 60 as taught by Suzuki et al. '752 to adjust the reflectivity" (Office Action, pages 4-5).

In Xu or Shuy, data is recorded by heating the transparent layer 30 and the reflecting layer 40 so that the transparent layer 30 and the reflecting layer 40 react to form a semi-transparent reflective area 35 as a recorded mark for recording the data. That is, the principle of operation for data recording in Xu or Shuy is by heating a transparent layer and a reflective layer to form a semi-transparent reflective area. No dye is used and neither the transparent layer 30 nor the reflecting layer 40 contains a dyestuff film. No uneven pits or grooves are used as the record mark for recording data.

Yoshida employs a totally different principle of operation. In Yoshida, data recording is rendered by chemical change of the dye in the dyestuff film 4 to cause changes in an

optical characteristic. There is no mixing of two different layers to form a semi-transparent reflective area as a record mark. Namely, the reflection film 3 is not mixed with the dyestuff film 4 by a laser beam for data recording. The chemical change that results in changes in an optical characteristic occurs only in one layer, the dyestuff film 4, and does not involve two different layers or the reflection film 3. Although Yoshida teaches a reflective film, the reflection film 3, having a composition of 70 to 90 atomic % of Cu and 1 to 30 atomic % of Al, the reflection film 3 is nevertheless not a part of the recording layer, which consists of only the dyestuff film 4.

Aratani too employs a totally different principle of operation. In Aratani, data recording is rendered by injection molding using a stamper to create uneven pits 12P or winding groove 12G in recording portions 12 of the information layer 2. There is no mixing of two different layers to form a semi-transparent reflective area as a record mark. Namely, the reflective film 3 is not mixed with the information layer 2 by a laser beam for data recording. Although Aratani teaches the reflective film 3 can be made of Cu-alloy film such as $Cu_{82.5}Al_{17.5}$, there is no disclosure that the information layer 2 contains an element selected from the group consisting of Si, Ge, Sn, Mg, In, Zn, Bi and Al as a primary component of that the information layer 2 contains Cu as a primary component and 10 to 30 atomic % of Al as an additive.

Therefore, the Examiner has failed to establish a *prima facie* case of obviousness as the proposed combination would require a substantial reconstruction and redesign of the elements in Xu or Shuy as well as a change in the basic principle under which the construction of Xu or Shuy's optical recording medium was designed to operate.

4. <u>There is No Suggestion or Motivation to Modify Xu or Shuy with Either of Yoshida or Aratani and Suzuki as the Proposed Modification Would Render Xu or Shuy Unsatisfactory for Its Intended Purpose.</u>

If proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. *In re Gordon*, 733 F.2d 900, 221 USPQ 1125 (1984).

As discussed above, data is recorded in Xu or Shuy by heating the transparent layer 30 and the reflecting layer 40 so that the transparent layer 30 and the reflecting layer 40

react to form a semi-transparent reflective area 35 as a recorded mark for recording the data. Yoshida records data by chemical change of the dyestuff in the dyestuff film 4 to cause changes in an optical characteristic. Aratani records data by physical change of shape, such as uneven pits or grooves, in the information layer 2.

If the optical recording medium of Xu or Shuy were somehow modified such that either or both of the transparent layer 30 and the reflecting layer 40 undergoes chemical change or physical change of shape as is the case in either of Yoshida or Aratani, rather than being mixed to form a semi-transparent reflective area, the optical recording medium of Xu or Shuy would not function properly as intended. To say otherwise is just hindsight reconstruction ignoring the objective of Xu or Shuy.

Therefore, the Examiner has failed to establish a *prima facie* case of obviousness as the proposed combination would render the optical recording medium of Xu or Shuy unsatisfactory for its intended purpose.

5. Reasonable Expectation of Success Is Not Found in the Cited References for the Modification of Xu or Shuy with Either of Yoshida or Aratani and Suzuki to Obtain the Features in the Claims.

Evidence showing there was no reasonable expectation of success may support a conclusion of nonobviousness. *In re Rinehart*, 531 F.2d 1048, 189 USPQ 143 (1976). See also *Amgen, Inc. v. Chugai Pharmaceutical Co.*, 927 F.2d 1200, 1207-08, 18 USPQ2d 1016, 1022-23, *cert. denied*, 502 U.S. 856 (1991); *In re O'Farrell*, 853 F.2d 894, 903, 7USPQ2d 1673, 1681 (1988). "Both the suggestion [to combine] and the *expectation of success*, must be founded in the prior art, not in the applicant's disclosure." *In re Dow Chemical Co.*, 5 U.S.P.Q.2d 1529, 1530 (Fed. Cir. 1988) (emphasis added).

The Examiner fails to show that a person with ordinary skill in the art would have expected success through the modification of Xu or Shuy with Either of Yoshida or Aratani and Suzuki, Morimoto, Shigeta and Kinoshita as set forth by the Examiner. As discussed above, the proposed combination fails to disclose the recited limitations and the particular interrelationship between limitations of each of the claims. Moreover, the proposed modification of Xu or Shuy

with either of Yoshida or Aratani and Suzuki would require a change in the principle of operation for Xu or Shuy and render Xu or Shuy unsatisfactory for its intended purpose.

Therefore, as there is no reasonable expectation of success for a person with ordinary skill in the art to obtain the recited features by the proposed modification, the Examiner has failed to establish a *prima facie* case of obviousness.

C. *Conclusion*

In summary, Appellants respectfully submit that claims 1-25 are patentable over the art of record because the Examiner has not supported a *prima facie* case of obviousness. Claims 1-25 are patentable over the art of record because (1) even if combined, and they are not, the cited references fail to disclose the recited limitations of each of claims 1, 11, 20, 22 and 24; (2) an ordinary person skilled in the art would not be motivated to combine the teachings of the cited references and each claim recites an interrelationship between elements that is not discussed or recognized in the art of record; (3) the proposed modification would change the principle of operation for Xu or Shuy; (4) the proposed modification would render Xu or Shuy unsatisfactory for its intended purpose; and (5) no reasonable expectation of success is found for obtaining the features of each claims 1, 11, 20, 22 and 24 through the modifications set forth by the Examiner. Appellants therefore respectfully request a speedy and favorable decision.

Respectfully submitted,
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VIII. CLAIMS APPENDIX

1. (Previously Presented) An optical recording medium comprising:

a substrate;

a reflective layer;

a light transmission layer; and

at least one recording layer positioned between the reflective layer and the light transmission layer, the recording layer being of the type in which data can be recorded by projecting a laser beam, the recording layer including a first recording film containing an element selected from the group consisting of Si, Ge, Sn, Mg, In, Zn, Bi and Al as a primary component and a second recording film containing Cu as a primary component and 10 to 30 atomic % of Al as an additive,

wherein the element contained in the first recording film as a primary component and the element contained in the second recording film as a primary component are mixed upon irradiation with the laser beam, and

wherein the light transmission layer is disposed on the opposite side to the substrate with respect to the recording layer and one surface of the light transmission layer constitutes a light incidence plane through which the laser beam enters the optical recording medium.

2. (Original) An optical recording medium in accordance with Claim 1, wherein the second recording film is formed so as to be in contact with the first recording film.

3. (Original) An optical recording medium in accordance with Claim 1, wherein the second recording film contains 10 to 25 atomic % of Al.

4. (Original) An optical recording medium in accordance with Claim 3, wherein the second recording film contains 20 to 25 atomic % of Al.

5. (Original) An optical recording medium in accordance with Claim 1, which further comprises a first dielectric layer and a second dielectric layer on the both sides of the recording layer.

6. (Original) An optical recording medium in accordance with Claim 2, which further comprises a first dielectric layer and a second dielectric layer on the both sides of the recording layer.

7. (Original) An optical recording medium in accordance with Claim 3, which further comprises a first dielectric layer and a second dielectric layer on the both sides of the recording layer.

8. (Original) An optical recording medium in accordance with Claim 4, which further comprises a first dielectric layer and a second dielectric layer on the both sides of the recording layer.

9. (Previously Presented) An optical recording medium in accordance with Claim 1, wherein the light transmission layer has a thickness of 10 to 300 μm.

10. (Original) An optical recording medium in accordance with Claim 1, wherein the laser beam has a wavelength of 380 nm to 450 nm.

11. (Previously Presented) An optical recording medium comprising:

a substrate;

a reflective layer;

a light transmission layer;

a plurality of information record layers positioned between the reflective layer and the light transmission layer, the recording being of the type in which data can be recorded by projecting a laser beam thereonto via the light transmission layer, at least one information recording layer other than an information recording layer farthest from a light incidence plane

through which a laser beam enters including a first recording film containing an element selected from the group consisting of Si, Ge, Sn, Mg, In, Zn, Bi and Al as a primary component and a second recording film containing Cu as a primary component and 10 to 30 atomic % of Al as an additive,

wherein the element contained in the first recording film as a primary component and the element contained in the second recording film as a primary component are mixed upon irradiation with the laser beam; and

wherein the light transmission layer is disposed on the opposite side to the substrate with respect to the recording layer and one surface of the light transmission layer constitutes a light incidence plane through which the laser beam enters the optical recording medium.

12. (Original) An optical recording medium in accordance with Claim 11, wherein the second recording film is formed so as to be in contact with the first recording film.

13. (Original) An optical recording medium in accordance with Claim 11, wherein the second recording film contains 10 to 25 atomic % of Al.

14. (Original) An optical recording medium in accordance with Claim 13, wherein the second recording film contains 20 to 25 atomic % of Al.

15. (Previously Presented) An optical recording medium in accordance with Claim 11, wherein the light transmission layer has a thickness of 10 to 300 μm.

16. (Previously Presented) An optical recording medium in accordance with Claim 12, wherein the light transmission layer has a thickness of 10 to 300 μm.

17. (Previously Presented) An optical recording medium in accordance with Claim 13, wherein the light transmission layer has a thickness of 10 to 300 μm.

18. (Previously Presented) An optical recording medium in accordance with Claim 14, wherein the light transmission layer has a thickness of 10 to 300 μm.

19. (Original) An optical recording medium in accordance with Claim 11, wherein the laser beam has a wavelength of 380 nm to 450 nm.

20. (Previously Presented) An optical recording medium in accordance with Claim 1, wherein the difference in the light transmittances of a mixed region of the first recording film and the second recording film and a region where the first recording film and the second recording film do not mix with each other is equal to or less than 3% for a laser beam having a wavelength of 380 nm to 450 nm.

21. (Previously Presented) An optical recording medium in accordance with Claim 20, wherein the difference in the light transmittances of a mixed region of the first recording film and the second recording film and a region where the first recording film and the second recording film do not mix with each other is equal to or less than 1% for a laser beam having a wavelength of 380 nm to 450 nm.

22. (Previously Presented) An optical recording medium in accordance with Claim 11, wherein the difference in the light transmittances of a mixed region of the first recording film and the second recording film and a region where the first recording film and the second recording film do not mix with each other is equal to or less than 3% for a laser beam having a wavelength of 380 nm to 450 nm.

23. (Previously Presented) An optical recording medium in accordance with Claim 22, wherein the difference in the light transmittances of a mixed region of the first recording film and the second recording film and a region where the first recording film and the second recording film do not mix with each other is equal to or less than 1% for a laser beam having a wavelength of 380 nm to 450 nm.

24. (Previously Presented) An optical recording medium comprising:

a substrate;

a reflective layer;

a light transmission layer; and

at least one recording layer positioned between the reflective layer and the light transmission layer, the recording being of the type in which data can be recorded by projecting a laser beam thereonto via the light transmission layer, the recording layer including a first recording film containing an element selected from the group consisting of Si, Ge, Sn, Mg, In, Zn, Bi and Al as a primary component and a second recording film containing Cu as a primary component and 10 to 30 atomic % of Al as an additive,

wherein the difference in the light transmittances of a mixed region of the first recording film and the second recording film and a region where the first recording film and the second recording film do not mix with each other is equal to or less than 3% for a laser beam having a wavelength of 380 nm to 450 nm; and

wherein the light transmission layer is disposed on the opposite side to the substrate with respect to the recording layer and one surface of the light transmission layer constitutes a light incidence plane through which the laser beam enters the optical recording medium.

25. (Previously Presented) An optical recording medium in accordance with Claim 24, wherein the difference in the light transmittances of a mixed region of the first recording film and the second recording film and a region where the first recording film and the second recording film do not mix with each other is equal to or less than 1% for a laser beam having a wavelength of 380 nm to 450 nm.

IX. EVIDENCE APPENDIX

Evidence Exhibit A is the Application as filed on January 26, 2004.

Evidence Exhibit B is a Final Office Action mailed on April 10, 2008.

Evidence Exhibit C is a Non-Final Office Action mailed on October 17, 2008.

X. RELATED PROCEEDINGS APPENDIX

None.

EXHIBIT A

EXPRESS MAIL NO. EV336653121US

SPECIFICATION

TITLE OF THE INVENTION

OPTICAL RECORDING MEDIUM

BACKGROUND OF THE INVENTION

The present invention relates to an optical recording medium and, particularly, to an optical recording medium which has an excellent initial recording characteristic and can store recorded data in a good condition over the long term.

DESCRIPTION OF THE PRIOR ART

Optical recording media such as the CD, DVD and the like have been widely used as recording media for recording digital data. These optical recording media can be roughly classified into optical recording media such as the CD-ROM and the DVD-ROM that do not enable writing and rewriting of data (ROM type optical recording media), optical recording media such as the CD-R and DVD-R that enable writing but not rewriting of data (write-once type optical recording media), and optical recording media such as the CD-RW and DVD-RW that enable rewriting of data (data rewritable type optical recording media).

Data are generally recorded in a ROM type optical recording medium using prepits formed in a substrate in the manufacturing process thereof, while in a data rewritable type optical recording medium a phase change material is generally used as the material of the recording layer and data are recorded utilizing changes in an optical characteristic caused by phase change of the phase change material.

On the other hand, in a write-once type optical recording medium, an organic dye such as a cyanine dye, phthalocyanine dye or azo dye is generally used as the material of the recording layer and data are recorded utilizing changes in an optical characteristic caused by chemical change of the organic dye, which change may be accompanied by physical deformation.

Unlike data recorded in a data rewritable type optical recording medium, data recorded in a write-once type optical recording medium cannot be erased and rewritten. This means that data recorded in a write-once type optical recording medium cannot be falsified, so that the write-once type optical recording medium is useful in the case where it is necessary to prevent data recorded in an optical recording medium from being falsified.

However, since an organic dye is degraded when exposed to sunlight or the like, it is difficult to improve long-time storage reliability in the case where an organic dye is used as the material of the recording layer. Therefore, it is desirable for improving long-time storage reliability of the write-once type optical recording medium to form the recording layer of a material other than an organic dye.

As disclosed in Japanese Patent Application Laid Open No. 62-204442, an optical recording medium formed by laminating two recording layers is known as an example of an optical recording medium whose recording layer is formed of a material other than an organic dye.

However, in the optical recording medium disclosed in Japanese Patent Application Laid Open No. 62-204442, it is difficult to store the initially recorded data in the recording layers in a good condition over the long term and since the surface smoothness of this optical recording medium is not necessarily good, the initial recording characteristic may be poor.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide an optical recording medium which has an excellent initial recording characteristic and can store recorded data in a good condition over the

long term.

The inventors of the present invention vigorously pursued a study for accomplishing the above object and, as a result, made the discovery that when a laser beam is used to record data in a recording layer composed of a first recording film containing an element selected from the group consisting of Si, Ge, Sn, Mg, In, Zn, Bi and Al as a primary component and a second recording film containing Cu as a primary component and 10 to 30 atomic % of Al as an additive, a record mark is formed by mixing both the primary component element of the first recording film and the primary component element of the second recording film to markedly change the reflection coefficient thereof and enable data to be recorded with high sensitivity. They the further discovered that data initially recorded with high sensitivity in the optical recording medium can be stored for a long time by utilizing the large difference in reflection coefficient between the region of the record mark including the primary component element of the first recording film and the primary component element of the second recording film, and the other regions and that jitter of a reproduced signal can be markedly decreased.

The present invention is based on this finding and according to the present invention, the above and other objects of the present invention can be accomplished by an optical recording medium comprising a substrate and a recording layer in which data can be recorded by projecting a laser beam thereonto, the recording layer including a first recording film containing an element selected from the group consisting of Si, Ge, Sn, Mg, In, Zn, Bi and Al as a primary component and a second recording film containing Cu as a primary component and 10 to 30 atomic % of Al as an additive.

In the present invention, the statement that the first recording film contains a certain element as a primary component means that the content of the element is maximum among the elements contained in the first recording film, while the statement that the second recording film contains Cu as a primary component means that the content of Cu is maximum among the elements contained in the second recording film.

In the present invention, it is not absolutely necessary for the second recording film to be in contact with the first recording film and it is sufficient for the second recording film to be so located in the vicinity of the first recording film as to enable formation of a mixed region including the primary component element of the first recording film and the primary component element of the second recording film, thereby forming a record mark when the region is irradiated with a laser beam. Further, one or more other layers such as a dielectric layer may be interposed between the first recording film and the second recording film.

In the present invention, it is preferable to form the second recording film so as to be in contact with the first recording film.

Although the reason why a mixed region including the primary component element of the first recording film and the primary component element of the second recording film can be formed, thereby forming a record mark when irradiated with a laser beam is not altogether clear, it is reasonable to conclude that the primary component elements of the first and second recording films are partially or totally fused or diffused, thereby forming a region where the primary component elements of the first and second recording films mix.

The reflection coefficient that the record mark thus formed by mixing the primary component elements of the first and second recording films exhibits with respect to a laser beam for reproducing information

and the reflection coefficient that other regions exhibit with respect to the laser beam for reproducing information are considerably different and, therefore, recorded information can be reproduced with high sensitivity by utilizing such large difference in the reflection coefficients.

In the present invention, it is necessary for the second recording film to contain 10 to 30 atomic % of Al.

In the case where the content of Al in the second recording film is less than 10 atomic % or exceeds 30 atomic %, jitter of a reproduced signal becomes worse and, further, in the case where the content of Al in the second recording film is less than 10 atomic %, the storage reliability of the optical recording medium becomes worse.

In the present invention, the second recording film preferably contains 10 to 25 atomic % of Al and more preferably contains 20 to 25 atomic % of Al.

In the case where the content of Al of the second recording film is equal to or less than 25 atomic %, it is possible to improve the recording sensitivity and in the case where the content of Al in the second recording film is 20 to 25 atomic %, it is possible to markedly reduce jitter of a reproduced signal. Further, since it is possible to further improve the recording sensitivity in the case where the content of Al in the second recording film is equal to or less than 20 atomic %, it is most preferable for the second recording film to contain about 20 atomic % of Al.

In a preferred aspect of the present invention, the optical recording medium further comprises a first dielectric layer and a second dielectric layer on the both sides of the recording layer.

In a preferred aspect of the present invention, the optical recording medium further comprises a light transmission layer having a thickness of 10 to 300 μm on the opposite side to the substrate with respect to the

recording layer and one surface of the light transmission layer constitutes a light incidence plane through which the laser beam enters the optical recording medium.

In the present invention, a laser beam preferably has a wavelength of 380 nm to 450 nm in order to obtain high modulation.

The above and other objects of the present invention can be also accomplished by an optical recording medium comprising a substrate and a plurality of information record layers in which data can be recorded by projecting a laser beam thereonto, at least one information recording layer other than a information recording layer farthest from a light incidence plane through which a laser beam enters including a first recording film containing an element selected from the group consisting of Si, Ge, Sn, Mg, In, Zn, Bi and Al as a primary component and a second recording film containing Cu as a primary component and 10 to 30 atomic % of Al as an additive.

According to the present invention, when a laser beam is used to record data in the at least one information recording other than a information recording layer farthest from the light incidence plane, since the element contained in the first recording film as a primary component and the element contained in the second recording film as a primary component are mixed to form a record mark and the reflection coefficient of the record mark is greatly different from those of regions where no record mark is formed, data can be recorded in the at least one information recording other than a information recording layer farthest from the light incidence plane with high sensitivity and data initially recorded with high sensitivity in the optical recording medium can be stored for a long time. Further, jitter of a reproduced signal can be markedly decreased.

Further, in the case of recording data in a farthest information recording layer from the light incidence plane and reproducing data from the farthest information recording layer, the amount of a laser beam projected onto the farthest information recording layer and the amount of the laser beam reflected by the farthest information recording layer and detected are influenced by information recording layers other than the farthest information recording layer. Accordingly, in the case where the light transmittance of a region of an information recording layer other than the farthest information recording layer where a record mark is formed and that of a blank region of the information recording layer other than the farthest information recording layer where no record mark is formed are greatly different from each other, when data are recorded in the farthest information recording layer and data recorded in the farthest information recording layer are reproduced by adjusting the focus of a laser beam on the farthest information recording layer and irradiating the farthest information recording layer with the laser beam, the amount of the laser beam projected onto the farthest information recording layer and the amount of the laser beam reflected by the farthest information recording layer and detected differ greatly depending upon whether the region of the information recording layer other than the farthest information recording layer through which the laser beam is projected is a region where a record mark is formed or a blank region. As a result, the recording characteristics of the farthest information recording layer and the amplitude of a signal reproduced from the farthest information recording layer change greatly depending upon whether the region of the information recording layer other than the farthest information recording layer through which the laser beam is projected is a region where a record mark is formed or a blank region. However, in a study done by the

inventors of the present invention, it was found that when the at least one information recording layer was irradiated with a laser beam, the difference in light transmittances between a region where a record mark was formed by mixing, an element selected from the group consisting of Si, Ge, Sn, Mg, In, Zn, Bi and Al and contained in the first recording film as a primary component and Cu contained in the second recording film as a primary component, and a blank region was small, and therefore, in the case of recording data in the farthest information recording layer from the light incidence plane or reproducing data from the farthest information recording layer by projecting a laser beam onto the farthest information recording layer via the at least one information recording layer, even if a region of the recording layer through which the laser beam is transmitted contains a region where a record mark is formed and a blank region, it is possible to record data in the farthest information recording layer from the light incidence plane and reproduce data from the farthest recording layer in a desired manner.

Since the difference in light transmittances between a region where a record mark is formed by mixing an element contained in the first recording film as a primary component and an element contained in the second recording film as a primary component and a blank region is particularly small with respect to a laser beam having a wavelength of 380 nm to 450 nm, in the present invention, it is preferable for a laser beam projected onto the plurality of information recording layers to have a wavelength of 380 nm to 450 nm.

The above and other objects and features of the present invention will become apparent from the following description made with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic perspective view showing an optical recording medium that is a preferred embodiment of the present invention.

Figure 2 is an enlarged schematic cross-sectional view of the part of the optical recording medium indicated by A in Figure 1.

Figure 3 is a schematic enlarged cross-sectional view showing an optical recording medium shown in Figures 1 and 2 after a recording layer was irradiated with a laser beam.

Figure 4 is a diagram showing the waveform of a pulse train pattern for modulating the power of a laser beam in the case of recording 2T signals in a recording layer of an optical recording medium shown in Figures 1 and 2.

Figure 5 is a diagram showing the waveform of a pulse train pattern for modulating the power of a laser beam in the case of recording 3T signals in a recording layer of an optical recording medium shown in Figures 1 and 2.

Figure 6 is a diagram showing the waveform of a pulse train pattern for modulating the power of a laser beam in the case of recording 4T signals in a recording layer of an optical recording medium shown in Figures 1 and 2.

Figure 7 is a diagram showing the waveform of a pulse pattern for modulating the power of a laser beam in the case of recording one among a 5T signal to an 8T signal in a recording layer of an optical recording medium shown in Figures 1 and 2.

Figure 8 is a partially enlarged schematic cross-sectional view showing an optical recording medium that is another preferred embodiment of the present invention.

Figure 9 is a schematic enlarged cross-sectional view showing details of an L0 information recording layer.

Figure 10 is a schematic enlarged cross-sectional view showing details of an L1 information recording layer.

Figure 11 is a schematic enlarged cross-sectional view showing an optical recording medium shown in Figure 8 after an L0 information recording layer was irradiated with a laser beam.

Figure 12 is a schematic enlarged cross-sectional view showing an optical recording medium shown in Figure 8 after an L1 information recording layer was irradiated with a laser beam.

Figure 13 is a diagram showing the waveform of a pulse train pattern for modulating the power of a laser beam in the case of recording 2T signals in an L1 information recording layer of an optical recording medium shown in Figure 8.

Figure 14 is a diagram showing the waveform of a pulse train pattern for modulating the power of a laser beam in the case of recording 3T signals in an L1 information recording layer of an optical recording medium shown in Figure 8.

Figure 15 is a diagram showing the waveform of a pulse train pattern for modulating the power of a laser beam in the case of recording 4T signals in an L1 information recording layer of an optical recording medium shown in Figure 8.

Figure 16 is a diagram showing the waveform of a pulse pattern for modulating the power of a laser beam in the case of recording one among a 5T signal to an 8T signal in an L1 information recording layer of an optical recording medium shown in Figure 8.

Figure 17 is a graph showing how jitter of a reproduced signal and an optimum recording power of a laser beam varied with an amount of Al

added to a second recording film in Working Example 1.

Figure 18 is a graph showing how light transmittances of optical recording medium samples #1 to #11 varied with an amount of Al added to a second recording film in Working Example 2.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 is a schematic perspective view showing an optical recording medium that is a preferred embodiment of the present invention and Figure 2 is a schematic enlarged cross-sectional view indicated by A in Figure 1.

As shown in Figure 1, an optical recording medium 10 according to this embodiment is formed disk-like and has an outer diameter of about 120 mm and a thickness of about 1.2 mm.

An optical recording medium 10 according to this embodiment is constituted as a write-once type optical recording medium and as shown in Figure 2, it includes a support substrate 11, a reflective layer 12 formed on the surface of the support substrate 11, a second dielectric layer 13 formed on the surface of the reflective layer 12, a recording layer 14 formed on the surface of the second dielectric layer 13, a first dielectric layer 15 formed on the surface of the recording layer 14 and a light transmission layer 16 formed on the surface of the first dielectric layer 15.

In this embodiment, as shown in Figure 1, a laser beam L having a wavelength of 380 nm to 450 nm is projected onto a light incidence plane 16a constituted by one surface of the light transmission layer 16, thereby recording data in the optical recording medium 10 or reproducing data from the optical recording medium 10.

The support substrate 11 serves as a support for ensuring mechanical strength and a thickness of about 1.2 mm required for the

optical recording medium 10.

The material used to form the support substrate 11 is not particularly limited insofar as the support substrate 11 can serve as the support of the optical recording medium 10. The support substrate 11 can be formed of glass, ceramic, resin or the like. Among these, resin is preferably used for forming the support substrate 11 since resin can be easily shaped. Illustrative examples of resins suitable for forming the support substrate 11 include polycarbonate resin, polyolefin resin, acrylic resin, epoxy resin, polystyrene resin, polyethylene resin, polypropylene resin, silicone resin, fluoropolymers, acrylonitrile butadiene styrene resin, urethane resin and the like. Among these, polycarbonate resin and polyolefin resin are most preferably used for forming the support substrate 11 from the viewpoint of easy processing, optical characteristics and the like and in this embodiment, the support substrate 11 is formed of polycarbonate resin. In this embodiment, since the laser beam L is projected via the light incident plane 16a located opposite to the support substrate 11, it is unnecessary for the support substrate 11 to have a light transmittance property.

As shown in Figure 2, grooves 11a and lands 11b are alternately and spirally formed on the surface of the support substrate 11 so as to extend from a portion in the vicinity of the center of the support substrate 11 toward the outer circumference. The grooves 11a and/or lands 11b serve as a guide track for the laser beam L.

The depth of the groove 11a is not particularly limited and is preferably set to 10 nm to 40 nm. The pitch of the grooves 11a is not particularly limited and is preferably set to 0.2 μm to 0.4 μm.

It is preferable to form the support substrate 11 by an injection molding process using a stamper but the support substrate 11 may

instead be formed using another process such as the 2P process.

The reflective layer 12 serves to reflect the laser beam L10 entering through the light transmission layer 16 so as to emit it from the light transmission layer 16.

The material used to form the reflective layer 12 is not particularly limited insofar as it can reflect a laser beam, and the reflective layer 12 can be formed of Mg, Al, Ti, Cr, Fe, Co, Ni, Cu, Zn, Ge, Ag, Pt, Au and the like. Among these materials, it is preferable to form the reflective layer 12 of a metal material having a high reflection characteristic, such as Al, Au, Ag, Cu or alloy containing at least one of these metals, such as alloy of Al and Ti.

The thickness of the reflective layer 12 is not particularly limited but is preferably from 5 nm to 300 nm, more preferably from 20 nm to 200 nm.

In the case where the thickness of the reflective layer 12 is thinner than 5 nm, it is difficult to reflect a laser beam L in a desired manner. On the other hand, in the case where the thickness of the reflective layer 12 exceeds 300 nm, the surface smoothness of the reflective layer 12 becomes worse and it takes a longer time for forming the reflective layer 12, thereby lowering the productivity of the optical recording medium 10.

The first dielectric layer 15 and the second dielectric layer 13 serve to protect the recording layer 14. Degradation of optically recorded data can be prevented over a long period by the first dielectric layer 15 and the second dielectric layer 13.

The material for forming the first dielectric layer 15 and the second dielectric layer 13 is not particularly limited insofar as it is transparent in the wavelength range of the laser beam L and the first dielectric layer 15 and the second dielectric layer 13 can be formed of a

dielectric material containing oxide, sulfide, nitride, carbide or a combination thereof, for example, as a primary component. In order to prevent the support substrate 11 from being deformed by heat and improve the characteristics of the first dielectric layer 15 and the second dielectric layer 13 for protecting the recording layer 14, it is preferable to form the first dielectric layer 15 and the second dielectric layer 13 of an oxide, sulfide, nitride or carbide of Al, Si, Ce, Ti, Zn, Ta or the like, such as Al_2O_3, AlN, ZnO, ZnS, GeN, GeCrN, CeO_2, SiO, SiO_2, Si_3N_4, SiC, La_2O_3, TaO, TiO_2, SiAlON (mixture of SiO_2, Al_2O_3, Si_3N_4 and AlN), LaSiON (mixture of La_2O_3, SiO_2 and Si_3N_4) or the like, or the mixture thereof, and it is particularly preferable to form the first dielectric layer 15 and the second dielectric layer 13 of a mixture of ZnS and SiO_2. In the case where the first dielectric layer 15 and the second dielectric layer 13 are formed of the mixture of ZnS and SiO_2, the mole ratio of ZnS to SiO_2 is preferably 80:20.

The first dielectric layer 15 and the second dielectric layer 13 may be formed of the same dielectric material or of different dielectric materials. Moreover, at least one of the first dielectric layer 15 and the second dielectric layer 13 may have a multi-layered structure including a plurality of dielectric films.

The thickness of the first dielectric layer 15 and the second dielectric layer 13 is not particularly limited but is preferably from 3 nm to 200 nm. If the first dielectric layer 15 or the second dielectric layer 13 is thinner than 3 nm, it is difficult to obtain the above-described advantages. On the other hand, if the first dielectric layer 15 or the second dielectric layer 13 is thicker than 200 nm, it takes a long time to form the first dielectric layers 15 and the second dielectric layers 13, thereby lowering the productivity of the optical recording medium 10, and cracks may be

generated in the optical recording medium 10 owing to stress present in the first dielectric layers 15 and/or the second dielectric layer 13.

The first dielectric layer 15 and the second dielectric layer 13 also serve to increase the difference in optical properties of the optical recording medium 10 between before and after data recording and it is therefore preferable to form the first dielectric layer 15 and the second dielectric layer 13 of a material having a high refractive index *n* in the wavelength range of the laser beam L. Further, since the recording sensitivity becomes low as the energy absorbed in the first dielectric layer 15 and the second dielectric layer 13 becomes large when the laser beam L is projected onto the optical recording medium 10 and data are to be recorded therein, it is preferable to form the first dielectric layer 15 and the second dielectric layer 13 of a material having a low extinction coefficient *k* in the wavelength range of the laser beam L.

The recording layer 14 is adapted for recording data therein and as shown in Figure 2, the recording layer 14 is constituted by laminating a first recording film 31 and a second recording film 32.

As shown in Figure 2, in this embodiment, the first recording film 31 is disposed on the side of the light transmission layer 16 and the second recording film 32 is disposed on the side of the support substrate 11.

In this embodiment, the first recording film 31 contains Si as a primary component and the second recording film 32 contains Cu as a primary component and 10 to 30 atomic % of Al as an additive.

In the case where Al is added to the second recording film 32 containing Cu as a primary component, jitter of a reproduced signal can be reduced. However, in the case where the content of Al in the second recording film is less than 10 atomic % or exceeds 30 atomic %, jitter of a

reproduced signal becomes worse and, further, in the case where the content of Al in the second recording film is less than 10 atomic %, the storage reliability of the optical recording medium becomes worse.

The second recording film 32 is preferably added with 10 to 25 atomic % of Al and more preferably added with 20 to 25 atomic % of Al.

It is preferable for the second recording film 32 to contain no element other than Cu and Al but the second recording film 32 may contain 1 atomic % or less of other elements than Cu and Al as impurities.

The surface smoothness of the first recording film 31 irradiated with the laser beam L10 becomes worse as the total thickness of the first recording film 31 and the second recording film 32 becomes thicker. As a result, the noise level of the reproduced signal becomes higher and the recording sensitivity is lowered. Therefore, it is preferable to form the total thickness of the first recording film 31 and the second recording film 32 thinner in order to prevent the surface smoothness of the first recording film 31 from becoming worse but in the case where the total thickness of the first recording film 31 and the second recording film 32 is too small, the change in reflection coefficient between before and after irradiation with the laser beam L10 is small, so that a reproduced signal having high strength (C/N ratio) cannot be obtained. Moreover, it becomes difficult to control the thickness of the first recording film 31 and the second recording film 32.

Therefore, in this embodiment, the first recording film 31 and the second recording film 32 are formed so that the total thickness thereof is from 2 nm to 40 nm. In order to obtain a reproduced signal having higher strength (C/N ratio) and further decrease the noise level of the reproduced signal, the total thickness of the first recording film 31 and the second recording film 32 is preferably from 2 nm to 20 nm and more preferably 2

nm to 15 nm.

The individual thicknesses of the first recording film 31 and the second recording film 32 are not particularly limited but in order to considerably improve the recording sensitivity and greatly increase the change in reflection coefficient between before and after irradiation with the laser beam L, the thickness of the first recording film 31 is preferably from 1 nm to 30 nm and the thickness of the second recording film 32 is preferably from 1 nm to 30 nm. Further, it is preferable to define the ratio of the thickness of the first recording film 31 to the thickness of the second recording film 32 (thickness of first recording film 31 / thickness of second recording film 32) to be from 0.2 to 5.0.

Each of the reflective layer 12, the second dielectric layer 13, the second recording film 32, the first recording film 31 and the first dielectric layer 15 can be formed using a gas phase growth process using chemical species containing elements for forming it. Illustrative examples of the gas phase growth processes include vacuum deposition (vacuum evaporation) process, sputtering process and the like but it is preferable to use the sputtering process.

The light transmission layer 16 serves to transmit a laser beam L and preferably has a thickness of 10 μm to 300 μm. More preferably, the light transmission layer 16 has a thickness of 50 μm to 150 μm.

The material used to form the light transmission layer 16 is not particularly limited but in the case where the light transmission layer 16 is to be formed by the spin coating process or the like, ultraviolet ray curable resin, electron beam curable resin or the like is preferably used. More preferably, the light transmission layer 16 is formed of acrylic ultraviolet ray curable resin or epoxy ultraviolet ray curable resin.

The light transmission layer 16 may be formed by adhering a sheet

made of light transmittable resin to the surface of the first dielectric layer 15 using an adhesive agent.

Data are recorded in the optical recording medium 10 of the above-described configuration, in the following manner, for example.

As shown in Figure 1, the recording layer 14 is first irradiated via the light transmission layer 16 with a laser beam L having predetermined power.

In order to record data with high recording density, it is preferable to project a laser beam L having a wavelength of 380 nm to 450 nm onto the optical recording medium 10 via an objective lens (not shown) having a numerical aperture NA of 0.7 or more.

In this embodiment, a laser beam L having a wavelength λ of 405 nm is projected onto the optical recording medium 10 via an objective lens having a numerical aperture NA of 0.85.

As shown in Figure 3, this results in formation at the region of the recording layer 14 irradiated with the laser beam L of a record mark M composed of a mixture of the primary component element of the first recording film 31 and the primary component element of the second recording film 32, thereby recording data in the optical recording medium 10.

When the record mark M is formed by mixing the element contained in the first recording film 31 as a primary component and the element contained in the second recording film 32 as a primary component, the reflection coefficient of the region where the record mark M is formed markedly changes. Since the reflection coefficient of the region where the record mark M is thus formed is therefore greatly different from that of the region surrounding the region of the record mark M, it is possible to record data with high sensitivity and store data

initially recorded with high sensitivity for a long time. Further, it is possible to obtain a high reproduced signal (C/N ratio) when recorded data are reproduced.

Moreover, in this embodiment, since 10 to 30 atomic % of Al is added to the second recording film 32 containing Cu as a primary component, jitter of a reproduced signal can be decreased.

Furthermore, in this embodiment, since Si contained in the first recording film 31 as a primary component and Cu contained in the second recording film 32 as a primary component are ordinary elements present in the natural environment, there is no risk of harm to the global environment.

Each of Figures 4 to 7 is a diagram showing the waveform of a pulse pattern for modulating the power of the laser beam L in the case of recording data in the recording layer 14 of the optical recording medium 10, where Figure 4 shows a pulse train pattern used in the case of recording 2T signals, Figure 5 shows a pulse train pattern used in the case of recording 3T signals, Figure 6 shows a pulse train pattern used in the case of recording 4T signals and Figure 7 shows a pulse train pattern used in the case of recording one among a 5T signal to an 8T signal.

As shown in Figures 4 to 7, the power of the laser beam L is modulated between two levels, a recording power $Pw1$ and a ground power $Pb1$ where $Pw1 > Pb1$.

The recording power $Pw1$ is set to such a high level that Si contained in the first recording film 31 as a primary component and Cu contained in the second recording film 32 as a primary component can be heated and mixed to form a record mark M when the laser beam L whose power is set to the recording power $Pw1$ is projected onto the recording layer 14. On the other hand, the ground power $Pb1$ is set to such an

extremely low level that regions of the recording layer 14 heated by irradiation with the laser beam L whose power is set to the recording power *Pw1* can be cooled by irradiation with the laser beam L whose power is set to the ground power *Pb1*.

As shown in Figure 4, in the case of recording 2T signals in the recording layer 14 of the optical recording medium 10, the power of the laser beam L is modulated so that it is increased from the ground power *Pb1* to the recording power *Pw* at the time t11 and decreased from the recording power *Pw* to the ground power *Pb* at the time t12 after passage of a predetermined time period t_{top}.

On the other hand, as shown in Figure 5, in the case of recording 3T signals in the recording layer 14 of the optical recording medium 10, the power of the laser beam L is modulated so that it is increased from the ground power *Pb1* to the recording power *Pw1* at the time t21, decreased from the recording power *Pw1* to the ground power *Pb1* at the time t22 after passage of a predetermined time period t_{top}, increased from the ground power *Pb1* to the recording power *Pw1* at the time t23 after passage of a predetermined time period t_{off} and decreased from the recording power *Pw1* to the ground power *Pb1* at the time t24 after passage of a predetermined time period t_{lp}.

Further, as shown in Figure 6, in the case of recording 4T signals in the recording layer 14 of the optical recording medium 10, the power of the laser beam L is modulated so that it is increased from the ground power *Pb* to the recording power *Pw* at the time t31, decreased from the recording power *Pw* to the ground power *Pb* at the time t32 after passage of a predetermined time period t_{top}, increased from the ground power *Pb* to the recording power *Pw* aat the time t33 after passage of a predetermined time period t_{off}, decreased from the recording power *Pw* to

the ground power Pb at the time t34 after passage of a predetermined time period t_{mp}, increased from the ground power Pb to the recording power Pw at the time t35 after passage of a predetermined time period t_{off} and decreased from the recording power Pw to the ground power Pb at the time t36 after passage of a predetermined time period t_{lp}.

Moreover, as shown in Figure 7, in the case of recording one among a 5T signal to a 8T signal in the recording layer 14 of the optical recording medium 10, the power of the laser beam L is modulated so that it is increased from the ground power $Pb1$ to the recording power $Pw1$, held at the recording power $Pw1$ during the time period t_{top}, the time periods t_{mp} and the time period t_{lp}, held at the ground power Pb during the time periods t_{off} and decreased from the recording power $Pw1$ to the ground power Pb at the time t48.

Figure 8 is a partially enlarged schematic cross-sectional view showing an optical recording medium that is another preferred embodiment of the present invention.

Similarly to the optical recording medium 10 shown in Figure 1, an optical recording medium 40 according to this embodiment is formed disk-like and has an outer diameter of about 120 mm and a thickness of about 1.2 mm.

As shown in Figure 8, the optical recording medium 40 according to this embodiment includes a support substrate 41, a transparent intermediate layer 42, a light transmission layer 43, an L0 information recording layer 50 formed between the support substrate 41 and the transparent intermediate layer 42, and an L1 information recording layer 60 formed between the transparent intermediate layer 42 and the light transmission layer 43, and a light incidence plane 43a through which a laser beam L enters is constituted by one surface of the light transmission

layer 43.

The L0 information recording layer 50 constitutes an information recording layer far from the light incidence plane 43a and the L1 information recording layer 60 constitutes an information recording layer close to the light incidence plane 43a.

The support substrate 41 is formed similarly to the support substrate 11 of the optical recording medium 10, and as shown in Figure 8, grooves 41a and lands 41b are formed on the surface thereof. The grooves 41a and/or lands 41b serve as a guide track for the laser beam L when data are to be recorded in or data are to be reproduced from the L0 information recording layer 50.

The transparent intermediate layer 42 serves to space the L0 information recording layer 50 and the L1 information recording layer 60 apart by a physically and optically sufficient distance.

As shown in Figure 8, grooves 42a and lands 42b are formed on the surface of the transparent intermediate layer 42. The grooves 42a and/or lands 42b serve as a guide track for the laser beam L when data are to be recorded in or data are to be reproduced from the L1 information recording layer 60.

The material for forming the transparent intermediate layer 42 is not particularly limited and an ultraviolet ray curable acrylic resin is preferably used for forming the transparent intermediate layer 42.

It is necessary for the transparent intermediate layer 42 to have sufficiently high light transmittance since the laser beam L passes through the transparent intermediate layer 42 when data are to be recorded in the L0 information recording layer 50 and data recorded in the L0 information recording layer 50 are to be reproduced.

The light transmission layer 43 is formed similarly to the light

transmission layer 16 of the optical recording medium 10.

Figure 9 is a schematic enlarged cross-sectional view showing details of the L0 information recording layer 50.

As shown in Figure 9, the L0 information recording layer 50 is constituted by laminating a fourth dielectric film 51, a second L0 recording film 52, a first L0 recording film 53 and a third dielectric film 54 from the side of the support substrate 41.

In this embodiment, the first L0 recording film 53 contains Si as a primary component and the second L0 recording film 52 contains Cu as a primary component and 10 to 30 atomic % of Al as an additive.

Figure 10 is a schematic enlarged cross-sectional view showing details of the L1 information recording layer 60.

As shown in Figure 10, the L1 information recording layer 60 is constituted by laminating a second dielectric film 61, a second L1 recording film 62, a first L1 recording film 63 and a first dielectric film 64.

In this embodiment, the first L1 recording film 63 contains Si as a primary component and the second L1 recording film 62 contains Cu as a primary component and 10 to 30 atomic % of Al as an additive.

In the case where data are to be recorded in the L0 information recording layer 50 and data recorded in the L0 information recording layer 50 are to be reproduced, a laser beam L is projected thereon through the L1 information recording layer 60 located closer to the light incidence plane 43a.

Therefore, it is necessary for the L1 information recording layer 60 to have a high light transmittance with respect to the laser beam L used for recording data and reproducing data. Concretely, the L1 information recording layer 60 preferably has a light transmittance equal to or higher than 40 % with respect to the laser beam L and more preferably has a

light transmittance equal to or higher than 50 %.

Each of the first dielectric film 64, the second dielectric film 61, the third dielectric film 54 and the fourth dielectric film 51 is formed of a similar material to those of the first dielectric layer 15 and the second dielectric layer 13 and in a similar manner of forming the first dielectric layer 15 and the second dielectric layer 13.

Figure 11 is a schematic enlarged cross-sectional view showing the optical recording medium 30 shown in Figure 8 after the L0 information recording layer 50 was irradiated with a laser beam L.

As shown in Figure 11, when the L0 information recording layer 50 of the optical recording medium 30 is irradiated with a laser beam L via a light incident plane 43a, Si contained in the first L0 recording film 53 as a primary component and Cu contained in the second L0 recording film 52 as a primary component are quickly fused or diffused and a region where Si and Cu are mixed is formed, thereby forming a record mark M.

As shown in Figure 11, when Si contained in the first L0 recording film 53 as a primary component and Cu contained in the second L0 recording film 53 as a primary component are mixed to form a record mark M, the reflection coefficient of a region where the record mark M has been formed greatly changes. Therefore, since the reflection coefficient of the region where the record mark M is formed is greatly different from that of the region of the L0 information recording layer 50 surrounding the region where the record mark M is formed, it is possible to obtain a high reproduced signal (C/N ratio) by reproducing data recorded in the L0 information recording layer 50.

Figure 12 is a schematic enlarged cross-sectional view showing the optical recording medium 30 shown in Figure 8 after the L1 information recording layer 60 was irradiated with a laser beam L.

As shown in Figure 12, when the L1 information recording layer 60 of the optical recording medium 30 is irradiated with a laser beam L via a light incident plane 43a, Si contained in the first L1 recording film 63 as a primary component and Cu contained in the second L1 recording film 62 as a primary component are quickly fused or diffused and a region where Si and Cu are mixed is formed, thereby forming a record mark M.

As shown in Figure 12, when Si contained in the first L1 recording film 63 as a primary component and Cu contained in the second L1 recording film 63 as a primary component are mixed to form a record mark M, the reflection coefficient of a region where the record mark M has been formed greatly changes. Therefore, since the reflection coefficient of the region where the record mark M is formed is greatly different from that of the region of the L1 information recording layer 60 surrounding the region where the record mark M is formed, it is possible to obtain a high reproduced signal (C/N ratio) by reproducing data recorded in the L1 information recording layer 60.

Since the laser beam L passes through the L1 information recording layer 60 when data are recorded in the L0 information recording layer 50 and when data are reproduced from the L0 information recording layer 50, it is necessary for the L1 information recording layer 60 to have a high light transmittance. However, the L1 information recording layer 60 having the above configuration has a light transmittance equal to or higher than 50 and it is therefore possible to record data in the L0 information recording layer 50.

Further, since the laser beam L passes through the L1 information recording layer 60 when data are recorded in the L0 information recording layer 50 and when data are reproduced from the L0 information recording layer 50, if the difference in light transmittances between a

region of the L1 information recording layer 60 where a record mark M is formed and a blank region of the L1 information recording layer 60 where no record mark M is formed is great, the amount of the laser beam L projected onto the L0 information recording layer 50 when data are recorded in the L0 information recording layer 50 greatly changes depending upon whether the region of the L1 information recording layer 60 through which the laser beam L passes is a region where a record mark M is formed or a blank region and when data are reproduced from the L0 information recording layer 50, the amount of the laser beam L reflected from the L0 information recording layer 50, transmitting through the L1 information recording layer 60 and detected greatly changes depending upon whether the region of the L1 information recording layer 60 through which the laser beam L passes is a region where a record mark M is formed or a blank region. As a result, the recording characteristics of the L0 information recording layer 50 and the amplitude of a signal reproduced from the L0 information recording layer 50 change greatly depending upon whether the region of the L1 information recording layer 60 through which the laser beam L passes is a region where a record mark M is formed or a blank region.

In particular, data recorded in the L0 information recording layer 50 cannot be reproduced in a desired manner if the region of the L1 information recording layer 60 through which the laser beam L passes contains a boundary between a region where a record mark M is formed and a blank region, because in such a case the distribution of the reflection coefficient is not uniform at the spot of the laser beam L.

In a study done by the inventors of the present invention, it was found that in order to record data in the L0 information recording layer 50 and reproduce data from the L0 information recording layer 50, it is

necessary for the difference in light transmittances between a region of the L1 information recording layer 60 where a record mark M is formed and a blank region of the L1 information recording layer 60 to be equal to or lower than 4 % and it is preferable for the difference to be equal to or lower than 2 %.

The inventors of the present invention further found that the difference in light transmittances for a laser beam having a wavelength of 350 nm to 450 nm between the region of a record mark M formed by mixing Si and Cu and a blank region of the L1 information recording layer 60 formed by laminating the first L1 recording film 63 containing Si as a primary component and the second L1 recording film 62 containing Cu as primary component is equal to or lower than 3 % and the difference in light transmittances for a laser beam having a wavelength of about 405 nm between a region of the L1 information recording layer 60 where a record mark M is formed and a blank region of the L1 information recording layer 60 is equal to or lower than 1 %.

Therefore, in this embodiment, when data are to be recorded in the L0 information recording layer 50, since the amount of the laser beam L projected onto the L0 information recording layer 50 hardly changes depending upon whether the region of the L1 information recording layer 60 through which the laser beam L passes is a region where a record mark M is formed or a blank region, the recording characteristics of the L0 information recording layer 50 can be markedly improved. Further, when data are reproduced from the L0 information recording layer 50, since the amount of the laser beam L reflected from the L0 information recording layer 50, transmitting through the L1 information recording layer 60 and detected hardly changes depending upon whether the region of the L1 information recording layer 60 through which the laser beam L

passes is a region where a record mark M is formed or a blank region, it is possible to prevent the amplitude of a signal reproduced from the L0 information recording layer 50 from changing greatly depending upon whether the region of the L1 information recording layer 60 through which the laser beam L passes is a region where a record mark M is formed or a blank region.

Furthermore, according to this embodiment, when data recorded in the L0 information recording layer 50 are reproduced, even if the region of the L1 information recording layer 60 through which the laser beam L passes contains a boundary between a region where a record mark M is formed and a blank region, data recorded in the L0 information recording layer 50 can be reproduced in a desired manner.

Each of Figures 13 to 16 is a diagram showing the waveform of a pulse train pattern for modulating the power of the laser beam L in the case of recording data in the L1 information recording layer 60 of the optical recording medium 40, where Figure 13 shows a pulse train pattern used in the case of recording 2T signals, Figure 14 shows a pulse train pattern used in the case of recording 3T signals, Figure 15 shows a pulse train pattern used in the case of recording 4T signals and Figure 16 shows a pulse train pattern used in the case of recording one among a 5T signal to an 8T signal.

As shown in Figures 13 to 16, the power of the laser beam L is modulated between three levels, a recording power $Pw2$, an intermediate power $Pm2$ and a ground power $Pb2$ where $Pw2 > Pm2 > Pb2$.

The recording power $Pw2$ is set to such a high level that Si contained in the first L1 recording film 63 as a primary component and Cu contained in the second L1 recording film 62 as a primary component can be heated and mixed to form a record mark M when the laser beam L

whose power is set to the recording power *Pw2* is projected onto the L1 information recording layer 60 and. On the other hand, the intermediate power *Pm2* and the ground power *Pb2* are set to such low levels that Si contained in the first L1 recording film 63 as a primary component and Cu contained in the second L1 recording film 62 as a primary component cannot be substantially mixed when the laser beam L whose power is set to the intermediate power *Pm2* or the ground power *Pb2* is projected onto the L1 information recording layer 60. In particular, the ground power *Pb2* is set to such an extremely low level that regions of the L1 information recording layer 60 heated by irradiation with the laser beam L whose power is set to the recording power *Pw2* can be cooled by irradiation with the laser beam L whose power is set to the ground power *Pb2*.

As shown in Figure 13, in the case of recording 2T signals in the L1 information recording layer 60 of the optical recording medium 40, the power of the laser beam L is modulated so that it is increased from the intermediate power *Pm2* to the recording power *Pw2*, decreased from the recording power *Pw2* to the ground power *Pb2* after passage of a predetermined time period t_{top}, and increased from the ground power *Pb2* to the intermediate power *Pm2* after passage of a predetermined time period t_{cl}.

On the other hand, as shown in Figure 14, in the case of recording 3T signals in the L1 information recording layer 60 of the optical recording medium 40, the power of the laser beam L is modulated so that it is increased from the intermediate power *Pm2* to the recording power *Pw2*, decreased from the recording power *Pw2* to the ground power *Pb2* after passage of a predetermined time period t_{top}, increased from the ground power *Pb2* to the recording power *Pw2* after passage of a

predetermined time period t_{off}, decreased from the recording power *Pw2* to the ground power *Pb2* after passage of a predetermined time period t_{lp}, and increased from the ground power *Pb2* to the intermediate power *Pm2* after passage of a predetermined time period t_{cl}.

Further, as shown in Figure 15, in the case of recording 4T signals in the L1 information recording layer 60 of the optical recording medium 40, the power of the laser beam L is modulated so that it is increased from the intermediate power *Pm2* to the recording power *Pw2*, decreased from the recording power *Pw2* to the ground power *Pb2* after passage of a predetermined time period t_{top}, increased from the ground power *Pb2* to the recording power *Pw2* after passage of a predetermined time period t_{off}, decreased from the recording power *Pw2* to the ground power *Pb2* after passage of a predetermined time period t_{mp}, increased from the ground power *Pb2* to the recording power *Pw2* after passage of a predetermined time period t_{off}, decreased from the recording power *Pw2* to the ground power *Pb2* after passage of a predetermined time period t_{lp}, and increased from the ground power *Pb2* to the intermediate power *Pm2* after passage of a predetermined time period t_{cl}.

Moreover, as shown in Figure 16, in the case of recording one among a 5T signal to a 8T signal in the L1 information recording layer 60 of the optical recording medium 40, the power of the laser beam L is modulated so that it is increased from the intermediate power *Pm2* to the recording power *Pw2*, held at the recording power *Pw2* during the time period t_{top}, the time periods t_{mp} and the time period t_{lp}, held at the ground power *Pb2* during the time periods t_{off} and the time period t_{cl} and increased from the ground power *Pb2* to the intermediate power *Pm2* after passage of the time period t_{cl}.

In the case where data are recorded in the L1 information

recording layer 60 of the optical recording medium 40 by modulating the power of a laser beam L using a pulse pattern shown in Figures 13 to 16, since the power of the laser beam L is modulated to the ground power *Pb2* immediately after being set to the recording power *Pw2*, even when data are recorded in the L1 information recording layer 60 provided with no reflective film, it is possible to prevent excessive heat from being accumulated in the L1 information recording layer 60 and it is therefore possible to prevent the degradation of characteristics of signals obtained by reproducing data recorded in the L1 information recording layer 60 caused by heat generated in the first L1 recording film 63 and the second L1 recording film 62 even though the L1 information recording layer 60 includes no reflective film.

WORKING EXAMPLES AND COMPARATIVE EXAMPLES

Hereinafter, working examples will be set out in order to further clarify the advantages of the present invention.

Working Example 1

An optical recording medium sample # 1 was fabricated in the following manner.

A disk-like polycarbonate substrate having a thickness of 1.1 mm and a diameter of 120 mm and formed with grooves and lands on the surface thereof was first fabricated by an injection molding process so that the track pitch (groove pitch) was equal to 0.32 μm.

Then, the polycarbonate substrate was set on a sputtering apparatus and a second dielectric layer containing a mixture of ZnS and SiO_2 and having a thickness of 25 nm, a second recording film containing Cu as a primary component and 10 atomic % of Al as an additive and

having a thickness of 5 nm, a first recording film containing Si as a primary component and having a thickness of 4 nm and a first dielectric film containing TiO_2 and having a thickness of 30 nm were sequentially formed on the surface of the polycarbonate substrate on which the grooves and lands were formed, using the sputtering process.

The mole ratio of ZnS to SiO_2 in the mixture of ZnS and SiO_2 contained in the second dielectric layer was 80:20.

Further, the polycarbonate substrate formed with the second dielectric layer, the second recording film, the first recording film and the first dielectric layer on the surface thereof was set on a spin coating apparatus and the first dielectric layer was coated using the spin coating method with a resin solution prepared by dissolving acrylic ultraviolet ray curable resin in a solvent to form a coating layer and the coating layer was irradiated with ultraviolet rays, thereby curing the acrylic ultraviolet ray curable resin to form a light transmission layer having a thickness of 100 μm.

Thus, the optical recording medium sample #1 was fabricated.

The optical recording medium sample #1 was set in an optical recording medium evaluation apparatus "DDU1000" (Product Name) manufactured by Pulstec Industrial Co., Ltd. and a laser beam which has a wavelength of 405 nm and whose power was modulated using a pulse train pattern shown in Figure 16 was focused onto the first recording film and the second recording film using an objective lens whose numerical aperture was 0.85 via the light transmission layer while the optical recording medium sample # 1 was rotated at a linear velocity of 5.3 m/sec, thereby recording random signals including 2T signals to 8T signals in the 1,7 RLL Modulation Code therein.

The pulse widths of the pulse train pattern were set so that t_{top} was

equal to 0.5T, t_{mp} and t_{lp} were equal to 0.4T and t_{cl} was equal to 1.2T.

The random signals were recorded in the optical recording medium sample # 1 by setting the recording power *Pw2* of the laser beam to 7.0 mW, while the intermediate power *Pm2* was fixed at 2.4 mW and the ground power of the laser beam was fixed at 0.1 mW.

Then, the optical recording medium sample # 1 was set in the above mentioned optical recording medium evaluation apparatus and a laser beam having a wavelength of 405 nm was focused onto the first recording film and the second recording film using an objective lens whose numerical aperture was 0.85 via the light transmission layer while the optical recording medium sample # 1 was rotated at a linear velocity of 5.3 m/sec, thereby reproducing a signal recorded in the optical recording medium sample # 1 and clock jitter of the reproduced was measured, thereby measuring the lowest clock jitter.

The fluctuation σ of a reproduced signal was measured using a time interval analyzer and the clock jitter was calculated as σ/Tw, where Tw was one clock period.

Then, similarly to the above, random signals were recorded in the optical recording medium sample # 1 while increasing the recording power *Pw2* of the laser beam in increments of 0.2 mW up to 10.0 mW and signals reproduced from the optical recording medium sample # 1 similarly to the above were measured.

The lowest clock jitter was determined from among the thus measured clock jitters and the recording power *Pw2* at which the clock jitter of the reproduced signal was lowest was determined as an optimum recording power of the laser beam.

Further, the optical recording medium samples # 1 were re-fabricated with the thickness of the first dielectric layer increased in

increments of 1 nm up to 33 nm and, similarly to the above, random signals were recorded in each of the optical recording medium samples # 1 while varying the recording power *Pw2* of the laser beam in increments of 0.2 mW within the range of 6.0 mW to 10.0 mW. Then, a signal was reproduced from each of the optical recording medium samples # 1 similarly to the above and the lowest clock jitter was obtained, thereby determining the recording power *Pw2* at which the clock jitter of a reproduced signal was lowest as an optimum recording power of the laser beam of each of optical recording medium samples # 1.

Then, the minimum value of the clock jitter among the thus obtained clock jitters of the optical recording medium samples # 1 was determined as the minimum clock jitter of the optical recording medium sample # 1 and the recording power *Pw2* at which the minimum clock jitter was obtained was determined as an optimum recording power of the optical recording medium sample # 1.

The results of the measurement are shown in Figure 17.

Further, optical recording medium samples # 2 to #11 were sequentially fabricated in the manner of fabricating the optical recording medium sample #1 except that the amount of Al added to the second recording film of each sample was varied within a range of 2 atomic % to 53 atomic % and the thickness of the first dielectric layer was varied within a range of 30 nm to 33 nm.

Each of the optical recording medium samples # 2 formed with the first dielectric layers having different thicknesses was set in the above mentioned optical recording medium evaluation apparatus and random signals were recorded in each the optical recording medium samples # 2 in the manner of recording the random signals in the optical recording medium sample #1.

The random signals were recorded in each of the optical recording medium samples # 2 with the recording power *Pw2* of the laser beam set at 6.0 mW, while the intermediate power *Pm2* was fixed at 2.4 mW and the ground power of the laser beam was fixed at 0.1 mW.

Then, each of the optical recording medium samples # 2 was set in the above mentioned optical recording medium evaluation apparatus and a signal recorded in each of the optical recording medium samples # 2 was reproduced in the manner of reproducing the signal from the optical recording medium sample #1 and clock jitter of the reproduced signal was measured.

Further, similarly to in the optical recording medium samples # 1, random signals were recorded in each of the optical recording medium samples # 2 by increasing the recording power *Pw2* of the laser beam in increments of 0.2 mW up to 10.0 mW and clock jitter of a signal reproduced from each sample was measured.

Then, the lowest clock jitter of each of the optical recording medium samples # 2 was determined from among the thus measured clock jitters of the signal reproduced from each sample and the recording power *Pw2* at which the clock jitter of a reproduced signal was lowest was determined as an optimum recording power of the laser beam of each of the optical recording medium samples # 2.

Then, the minimum value of the clock jitter among the thus obtained clock jitters of the optical recording medium samples # 2 was determined as the minimum clock jitter of the optical recording medium sample # 2 and the recording power *Pw2* at which the minimum clock jitter was obtained was determined as an optimum recording power of the optical recording medium sample # 2.

The results of the measurement are shown in Figure 17.

Similarly to in the optical recording medium sample # 1 and # 2, the minimum clock jitter and an optimum recording power of each of the optical recording medium samples # 3 to # 11 were determined.

The results of the measurement are shown in Figure 17.

As shown in Figure 17, it was found that in the case where the amount of Al added to the second recording film was 10 atomic % to 30 atomic %, jitter of the reproduced signal was equal to or lower than 6 %, i.e., jitter could be sufficiently reduced, and it was further found that in the case where the amount of Al added to the second recording film was 20 atomic % to 25 atomic %, jitter of the reproduced signal could be markedly reduced.

Moreover, as shown in Figure 17, it was found that in the case where the amount of Al added to the second recording film was equal to or less than 25 atomic %, the optimum recording power of the laser beam was equal to or lower than 8.5 mW and the recording sensitivity was improved, and it was further found that in the case where the amount of Al added to the second recording film was 10 atomic % to 20 atomic %, the optimum recording power of the laser beam was equal to or lower than 8.0 mW and the recording sensitivity was markedly improved.

Working Example 2

Each of the optical recording medium samples #1 to #11 was irradiated with a laser beam having a wavelength of 405 nm and the amount of the laser beam transmitted through each of the optical recording medium samples #1 to #11 was measured, thereby measuring the light transmittance of each sample.

The results of the measurement are shown in Figure 18.

As shown in Figure 18, it was found that the optical recording

samples in which the amount of Al added to the second recording film was 10 atomic % to 30 atomic % had light transmittances equal to or higher than 50 %, i.e., they had sufficiently high light transmittances.

The present invention has thus been shown and described with reference to specific embodiments and working examples. However, it should be noted that the present invention is in no way limited to the details of the described arrangements but changes and modifications may be made without departing from the scope of the appended claims.

For example, in the embodiment shown in Figure 8, although the optical recording medium 40 includes the L0 information recording layer 50 and the L1 information recording layer 50 as information recording layers, it is not absolutely necessary for the optical recording medium 40 to include the L0 information recording layer 50 and the L1 information recording layer 60 as information recording layers and the optical recording medium may include three or more information recording layers.

Moreover, in the embodiment shown in Figure 8, although the L0 information recording layer 50 is constituted by laminating the fourth dielectric film 51, the second L0 recording film 52, the first L0 recording film 53 and the third dielectric film 54 from the side of the support substrate 41, the L0 information recording layer 50 may include a reflective film between the support substrate 11 and the fourth dielectric film 51. In such a case, the reflective film may be formed of Mg, Al, Ti, Cr, Fe, Co, Ni, Cu, Zn, Ge, Ag, Pt, Au and the like, and among these materials, it is preferable to form the reflective film of a metal material having a high reflection characteristic, such as Al, Au, Ag, Cu or alloy containing at least one of these metals, such as alloy of Al and Ti.

Further, in the embodiment shown in Figures 1 and 2, although

the first recording film 31 and the second recording film 32 of the recording layer 14 are formed in contact with each other it is not absolutely necessary to form the first recording film 31 and the second recording film 32 of the recording layer 14 in contact with each other but it is sufficient for the second recording film 32 to be so located in the vicinity of the first recording film 31 as to enable formation of a mixed region including the primary component element of the first recording film 31 and the primary component element of the second recording film 32 when the region is irradiated with a laser beam. Further, one or more other films such as a dielectric film may be interposed between the first recording film 31 and the second recording film 32.

Furthermore, in the embodiment shown in Figure 8, although the first L1 recording film 63 and the second L1 recording film 62 of the L1 information recording layer 60 are formed in contact with each other it is not absolutely necessary to form the first L1 recording film 63 and the second L1 recording film 62 of the L1 information recording layer 60 in contact with each other but it is sufficient for the second L1 recording film 62 to be so located in the vicinity of the first L1 recording film 63 as to enable formation of a mixed region including the primary component element of the first L1 recording film 63 and the primary component element of the second L1 recording film 62 when the region is irradiated with a laser beam. Further, one or more other films such as a dielectric film may be interposed between the first L1 recording film 63 and the second L1 recording film 62.

Moreover, in the embodiment shown in Figure 8, although the first L0 recording film 53 and the second L0 recording film 52 of the L0 information recording layer 50 are formed in contact with each other it is not absolutely necessary to form the first L0 recording film 53 and the

second L0 recording film 52 of the L0 information recording layer 50 in contact with each other but it is sufficient for the second L0 recording film 52 to be so located in the vicinity of the first L0 recording film 53 as to enable formation of a mixed region including the primary component element of the first L0 recording film 53 and the primary component element of the second L0 recording film 52 when the region is irradiated with a laser beam. Further, one or more other films such as a dielectric film may be interposed between the first L0 recording film 53 and the second L0 recording film 52.

Further, in the embodiment shown in Figure 8, although the optical recording medium 40 includes the L0 information recording layer 50, it is not absolutely necessary for the optical recording medium 40 to include the L0 information recording layer 50 and instead of the L0 information recording layer 50, the support substrate 41 or the transparent intermediate layer 42 can be utilized as a recording layer adapted to enable only data reading by forming pits on the surface of the support substrate 41 or the transparent intermediate layer 42 and recording data therein.

Furthermore, in the embodiment shown in Figures 1 and 2, although the first recording film 31 of the recording layer 14 contains Si as a primary component, it is not absolutely necessary for the first recording film 31 of the recording layer 14 to contain Si as a primary component and the first recording film 31 of the recording layer 14 may contain an element selected from the group consisting of Ge, Sn, Mg, In, Zn, Bi and Al instead of Si.

Moreover, in the embodiment shown in Figure 8, although each of the second L0 recording film 53 and the second L1 recording film 63 contains Cu as a primary component, it is not absolutely necessary for

each of the second L0 recording film 53 and the second L1 recording film 63 to contain Cu as a primary component and each of the second L0 recording film 53 and the second L1 recording film 63 may contain an element selected from the group consisting of Al, Zn, Ti and Ag instead of Cu.

Further, in the embodiment shown in Figures 1 and 2, although the first recording film 31 is disposed on the side of the light transmission layer 16 and the second recording film 32 is disposed on the side of the support substrate 11, it is possible to dispose the first recording film 31 on the side of the support substrate 11 and the second recording film 32 on the side of the light transmission layer 16.

Furthermore, in the embodiment shown in Figure 8, although the first L0 recording film 53 is disposed on the side of the light transmission layer 43 and the second L0 recording film 52 is disposed on the side of the support substrate 41, it is possible to dispose the first L0 recording film 53 on the side of the support substrate 41 and the second L0 recording film 52 on the side of the light transmission layer 43.

Moreover, in the embodiment shown in Figure 8, although the first L1 recording film 63 is disposed on the side of the light transmission layer 43 and the second L1 recording film 62 is disposed on the side of the support substrate 41, it is possible to dispose the first L1 recording film 63 on the side of the support substrate 41 and the second L1 recording film 62 on the side of the light transmission layer 43.

Further, in the embodiment shown in Figures 1 and 2, although the reflective layer 12 is provided on the support substrate 11, in order to prevent the reflective layer 12 from being corroded, it is possible to form a moisture-proof layer between the support substrate 11 and the reflective layer 12.

Furthermore, in the embodiment shown in Figures 1 and 2, although the optical recording medium 10 includes the reflective layer 12 and it is preferable to provide the reflective layer 12 in order to obtain a higher reproduced signal (C/N ratio) by a multiple interference effect, it is not absolutely necessary for the optical recording medium 10 to include the reflective layer 12.

Moreover, in the embodiment shown in Figure 8, although the L1 information recording layer 60 includes no reflective film, the L1 information recording layer 60 may include a thin reflective film.

Furthermore, the optical recording medium 10 includes the light transmission layer 16 and is constituted so that a laser beam L is projected onto the recording layer 14 via the light transmission layer 16 in the embodiment shown in Figures 1 and 2 and the optical recording medium 40 includes the light transmission layer 43 and is constituted so that a laser beam L is projected onto the L0 information recording layer 50 or the L1 information recording layer 60 via the light transmission layer 43 in the embodiment shown in Figure 8. However, the present invention is not limited to an optical recording medium having such a configuration and the optical recording medium may include a substrate formed of a light transmittable material and be constituted so that a laser beam L is projected onto the recording layer 14 or the L0 information recording layer 50 or the L1 information recording layer 60 via the substrate.

According to the present invention, it is possible to provide an optical recording medium which has an excellent initial recording characteristic and can store recorded data in a good condition over the long term.

CLAIMS:

1. An optical recording medium comprising a substrate and a recording layer in which data can be recorded by projecting a laser beam thereonto, the recording layer including a first recording film containing an element selected from the group consisting of Si, Ge, Sn, Mg, In, Zn, Bi and Al as a primary component and a second recording film containing Cu as a primary component and 10 to 30 atomic % of Al as an additive.

2. An optical recording medium in accordance with Claim 1, wherein the second recording film is formed so as to be in contact with the first recording film.

3. An optical recording medium in accordance with Claim 1, wherein the second recording film contains 10 to 25 atomic % of Al.

4. An optical recording medium in accordance with Claim 3, wherein the second recording film contains 20 to 25 atomic % of Al.

5. An optical recording medium in accordance with Claim 1, which further comprises a first dielectric layer and a second dielectric layer on the both sides of the recording layer.

6. An optical recording medium in accordance with Claim 2, which further comprises a first dielectric layer and a second dielectric layer on the both sides of the recording layer.

7. An optical recording medium in accordance with Claim 3, which further comprises a first dielectric layer and a second dielectric layer on

the both sides of the recording layer.

8. An optical recording medium in accordance with Claim 4, which further comprises a first dielectric layer and a second dielectric layer on the both sides of the recording layer.

9. An optical recording medium in accordance with Claim 1, which further comprises a light transmission layer having a thickness of 10 to 300 µm on the opposite side to the substrate with respect to the recording layer and one surface of the light transmission layer constitutes a light incidence plane through which the laser beam enters the optical recording medium.

10. An optical recording medium in accordance with Claim 1, wherein the laser beam has a wavelength of 380 nm to 450 nm.

11. An optical recording medium comprising a substrate and a plurality of information record layers in which data can be recorded by projecting a laser beam thereonto, at least one information recording layer other than a information recording layer farthest from a light incidence plane through which a laser beam enters including a first recording film containing an element selected from the group consisting of Si, Ge, Sn, Mg, In, Zn, Bi and Al as a primary component and a second recording film containing Cu as a primary component and 10 to 30 atomic % of Al as an additive.

12. An optical recording medium in accordance with Claim 11, wherein the second recording film is formed so as to be in contact with the

first recording film.

13. An optical recording medium in accordance with Claim 11, wherein the second recording film contains 10 to 25 atomic % of Al.

14. An optical recording medium in accordance with Claim 13, wherein the second recording film contains 20 to 25 atomic % of Al.

15. An optical recording medium in accordance with Claim 11, which further comprises a light transmission layer having a thickness of 10 to 300 μm on the opposite side to the substrate with respect to the recording layer and one surface of the light transmission layer constitutes a light incidence plane through which the laser beam enters the optical recording medium.

16. An optical recording medium in accordance with Claim 12, which further comprises a light transmission layer having a thickness of 10 to 300 μm on the opposite side to the substrate with respect to the recording layer and one surface of the light transmission layer constitutes a light incidence plane through which the laser beam enters the optical recording medium.

17. An optical recording medium in accordance with Claim 13, which further comprises a light transmission layer having a thickness of 10 to 300 μm on the opposite side to the substrate with respect to the recording layer and one surface of the light transmission layer constitutes a light incidence plane through which the laser beam enters the optical recording medium.

18. An optical recording medium in accordance with Claim 14, which further comprises a light transmission layer having a thickness of 10 to 300 µm on the opposite side to the substrate with respect to the recording layer and one surface of the light transmission layer constitutes a light incidence plane through which the laser beam enters the optical recording medium.

19. An optical recording medium in accordance with Claim 11, wherein the laser beam has a wavelength of 380 nm to 450 nm.

ABSTRACT OF THE DISCLOSURE

An optical recording medium includes a substrate and a recording layer in which data can be recorded by projecting a laser beam thereonto, the recording layer including a first recording film containing an element selected from the group consisting of Si, Ge, Sn, Mg, In, Zn, Bi and Al as a primary component and a second recording film containing Cu as a primary component and 10 to 30 atomic % of Al as an additive.

The thus constituted optical recording medium has an excellent initial recording characteristic and can store recorded data in a good condition over the long term.

FIG.1

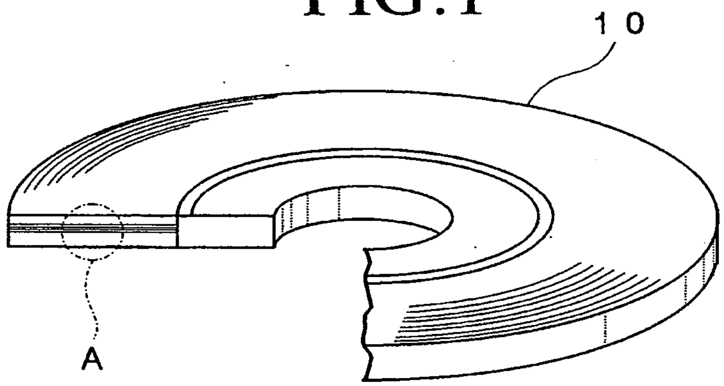


FIG.2

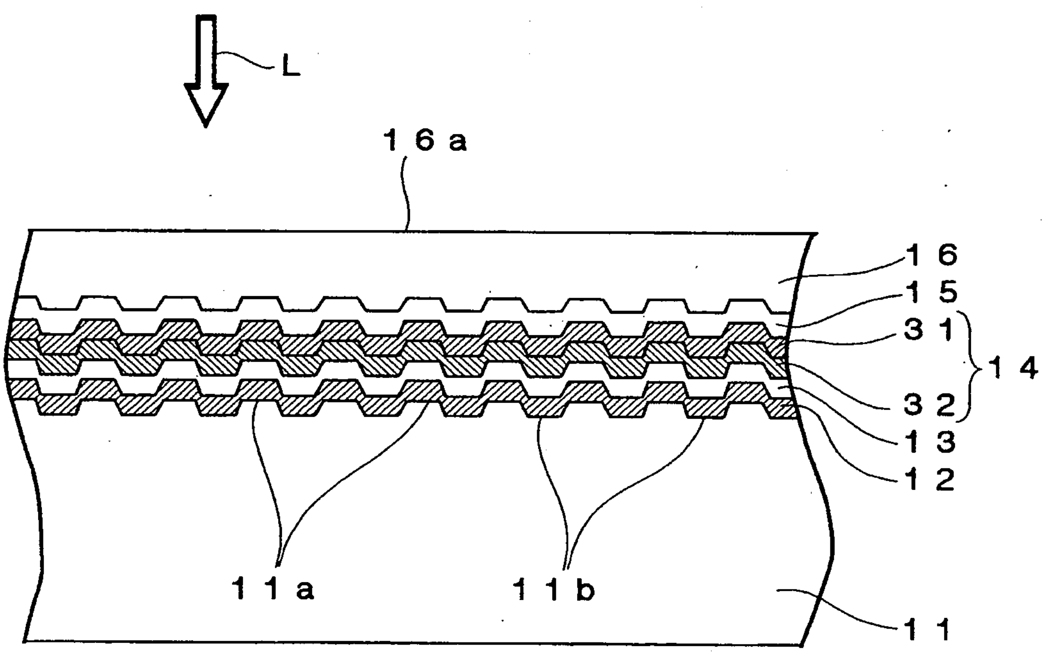


FIG.3

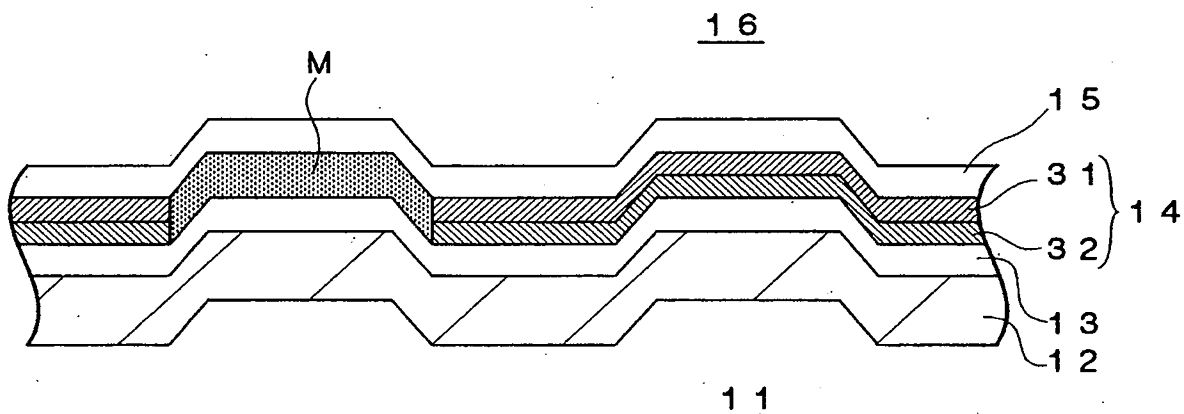


FIG.4

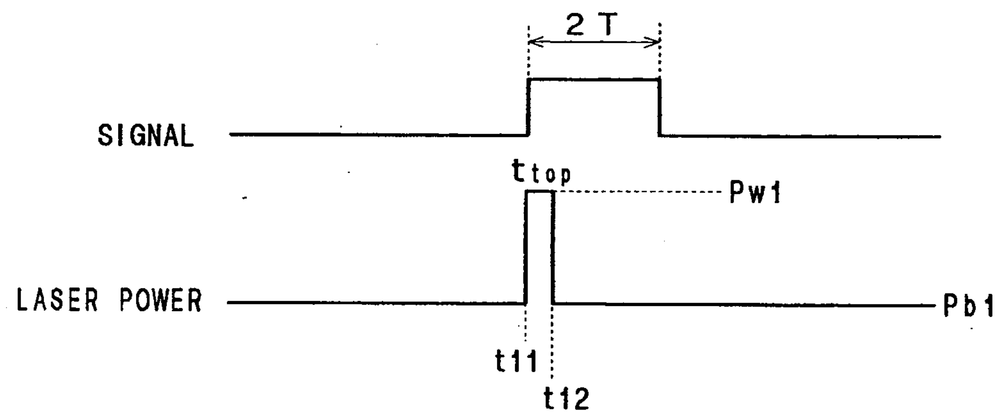
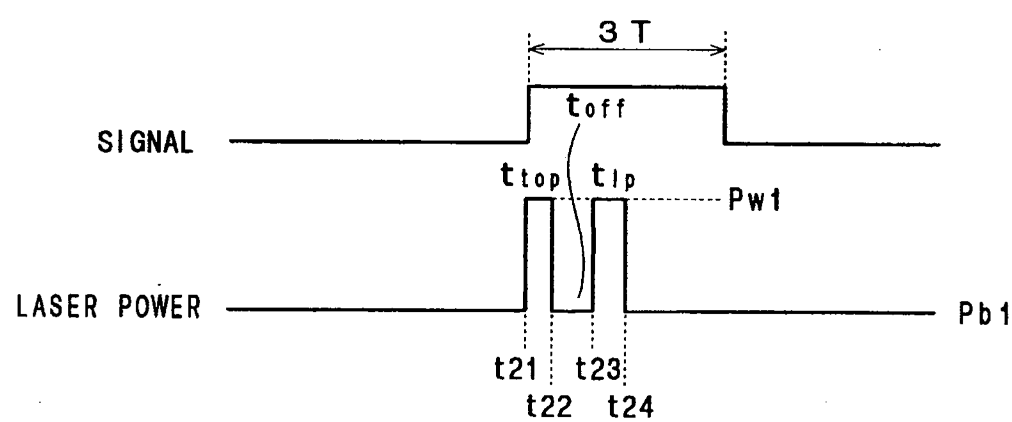

2 T
SIGNAL
t_{top}
Pw1
LASER POWER
Pb1
t11
t12

FIG.5


3 T
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SIGNAL
t_{top}
t_{lp}
Pw1
LASER POWER
Pb1
t21
t22
t23
t24

FIG.6

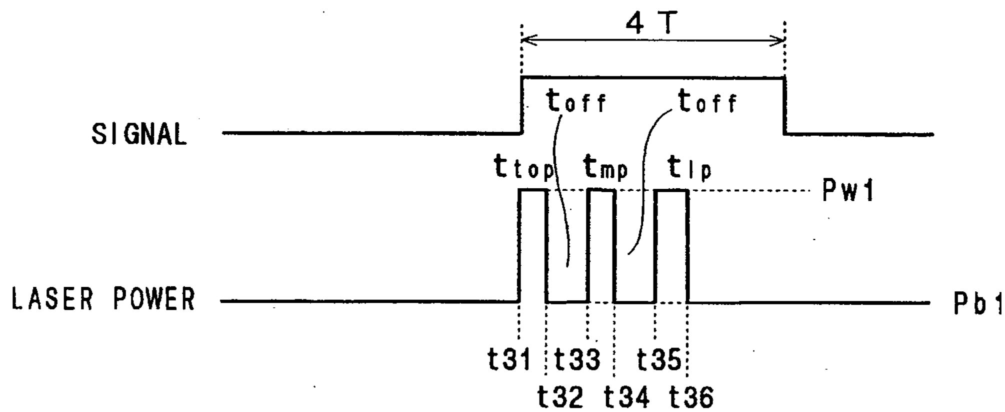
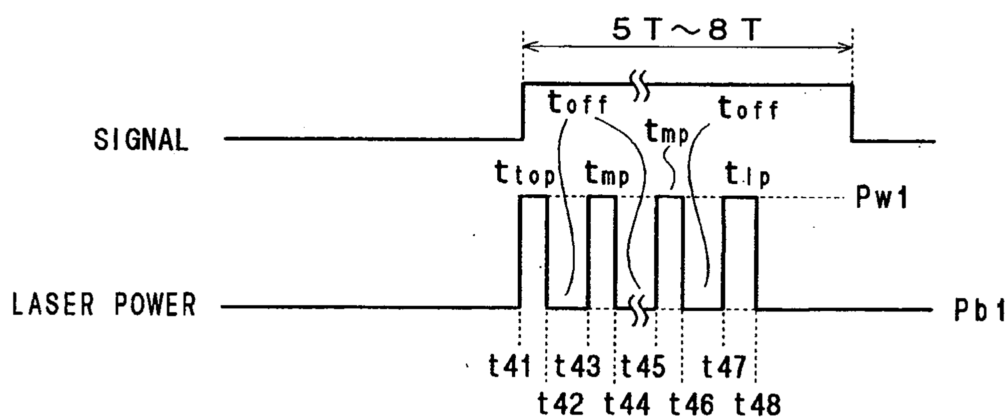

4T
SIGNAL
toff
toff
ttop
tmp
tlp
Pw1
LASER POWER
Pb1
t31
t33
t35
t32
t34
t36

FIG.7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SIGNAL
toff
tmp
toff
ttop
tmp
tlp
Pw1
LASER POWER
Pb1
t41
t43
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t44
t46
t48

FIG.8

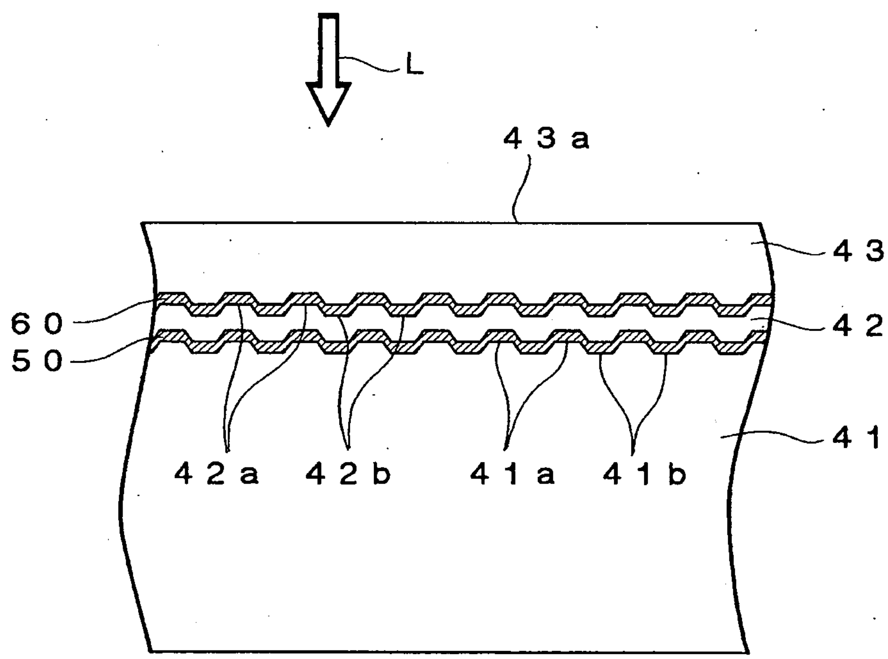


FIG.9

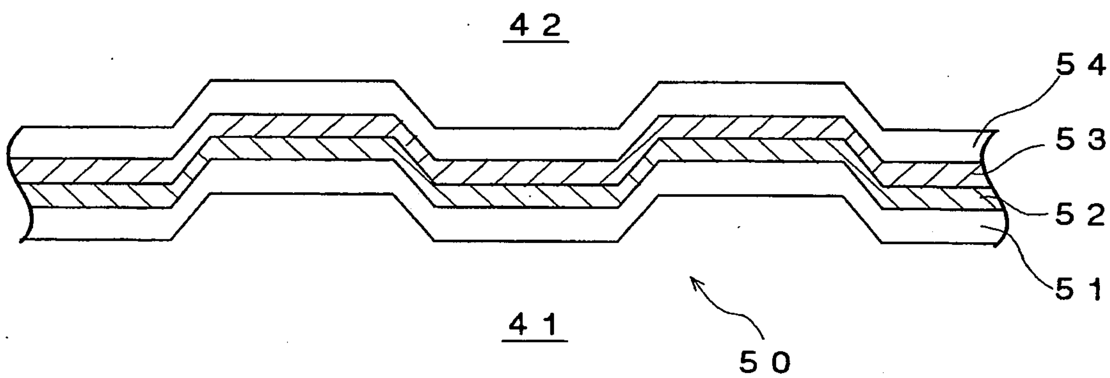


FIG.10

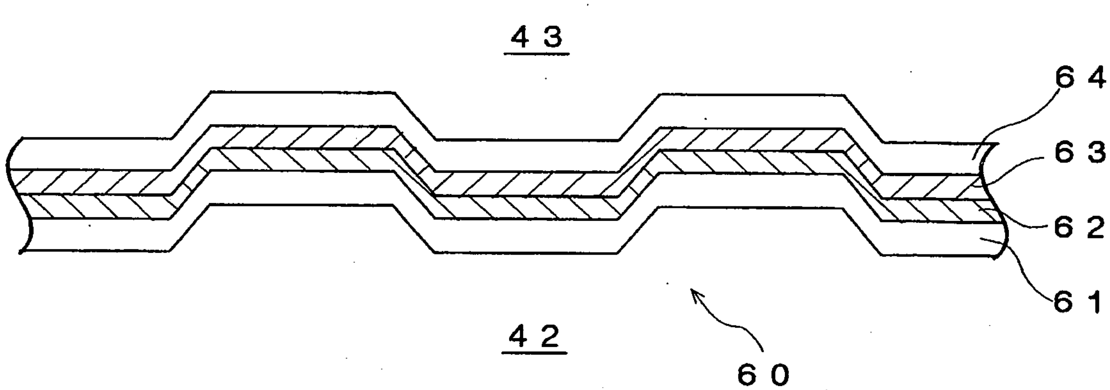


FIG.11

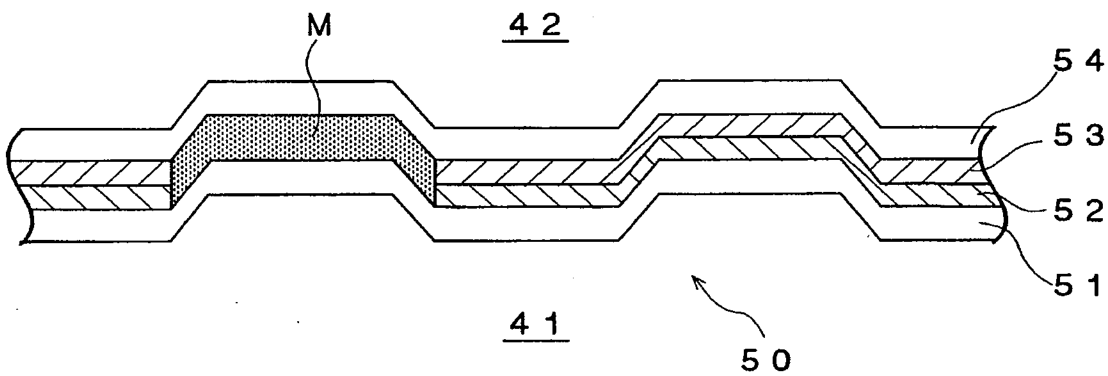


FIG.12

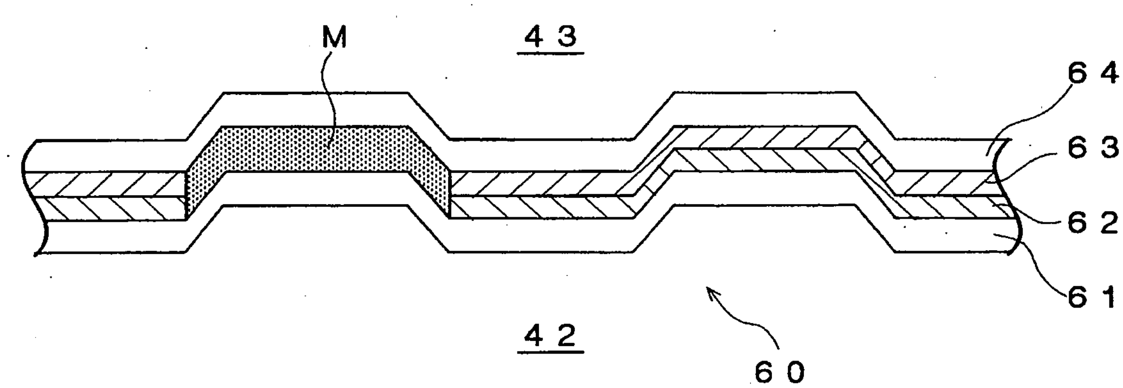
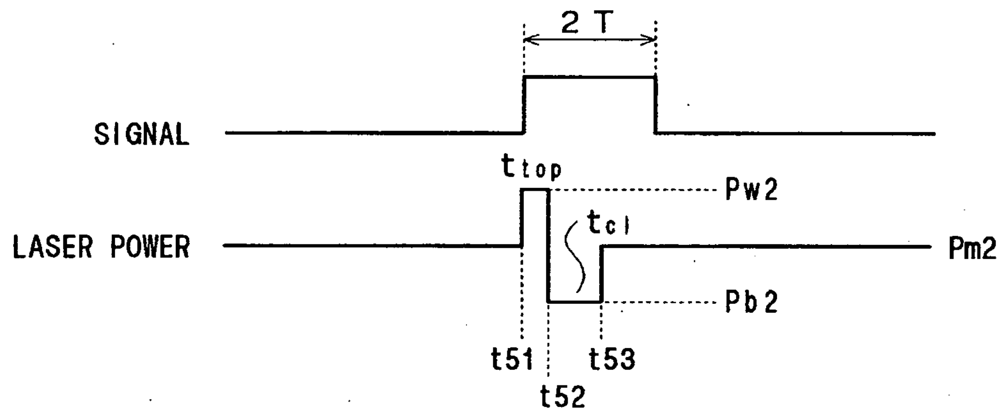


FIG.13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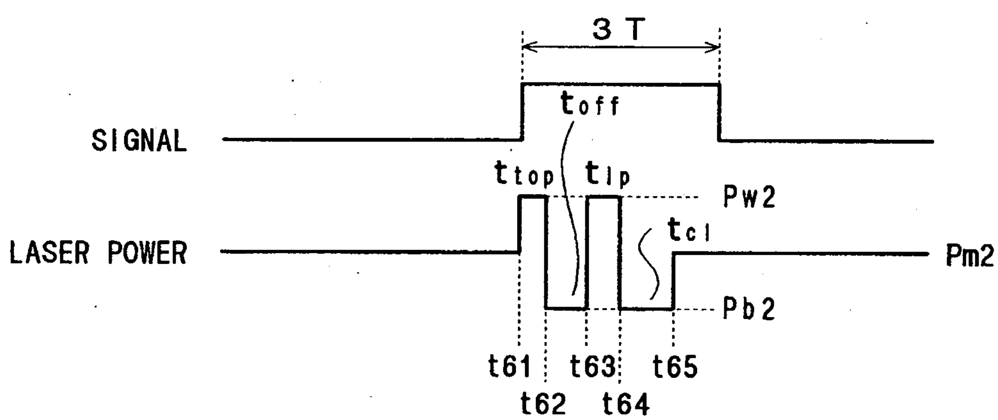
ttop
Pw2
tcl
LASER POWER
Pm2
Pb2
t51
t52
t53

FIG.14


3 T
SIGNAL
toff
ttop
tlp
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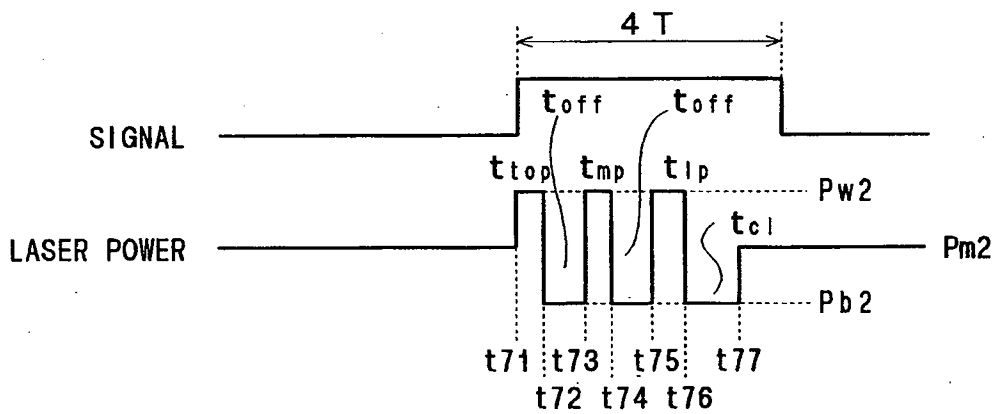
LASER POWER
Pm2
Pb2
t61
t62
t63
t64
t65

FIG.15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SIGNAL
LASER POWER
t_{off}
t_{off}
t_{top}
t_{mp}
t_{lp}
t_{cl}
Pw2
Pm2
Pb2
t71
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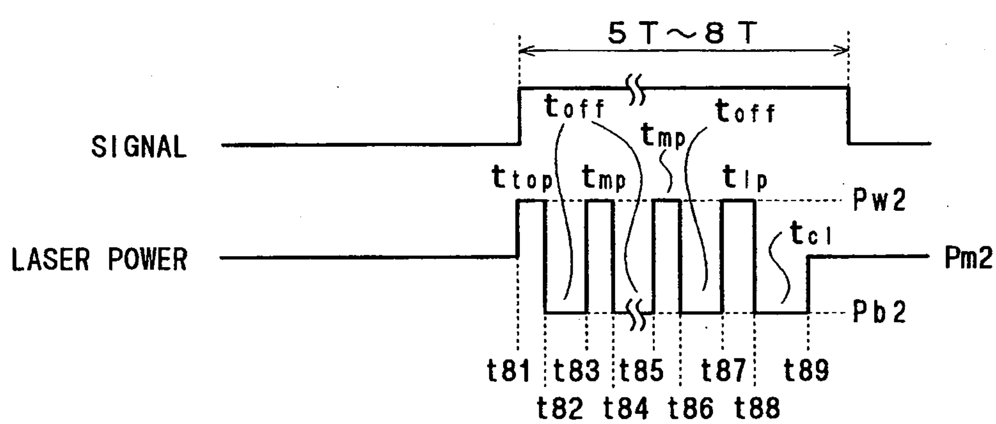
t73
t74
t75
t76
t77

FIG.16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SIGNAL
LASER POWER
t_{off}
t_{mp}
t_{off}
t_{top}
t_{mp}
t_{lp}
t_{cl}
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Pm2
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t87
t88
t89

FIG.17

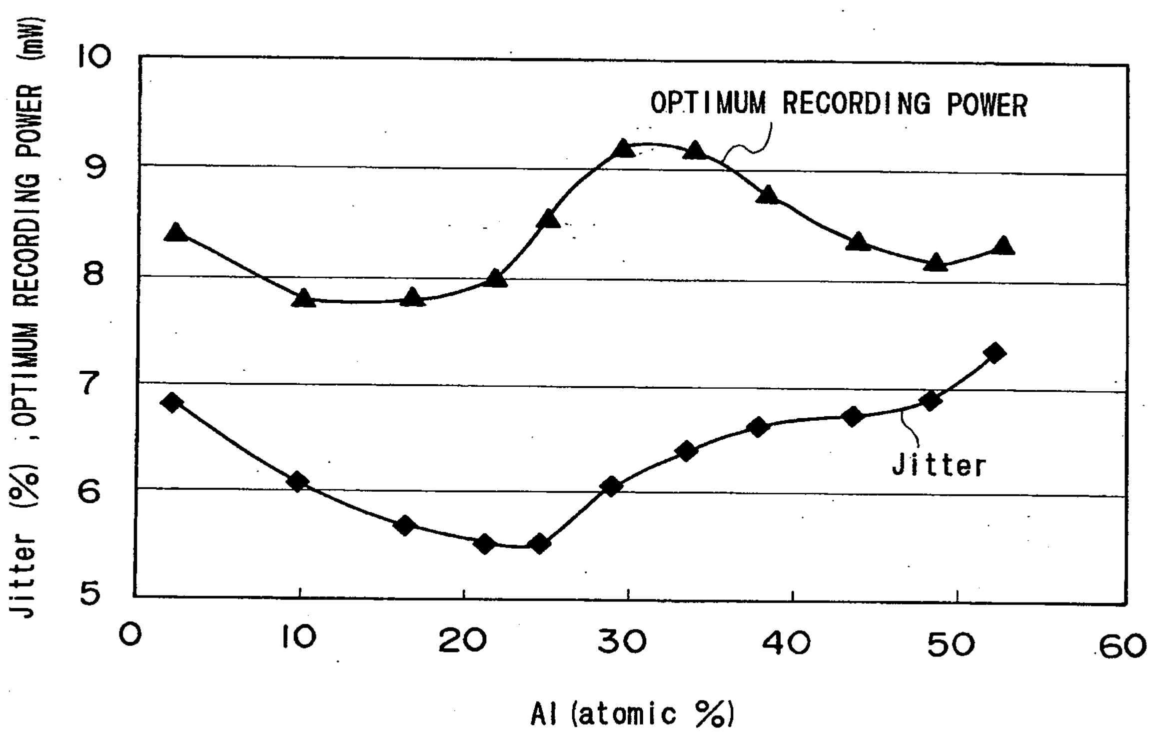
Jitter (%) , OPTIMUM RECORDING POWER (mW)
10
9
8
7
6
5
OPTIMUM RECORDING POWER
Jitter
0
10
20
30
40
50
60
Al (atomic %)

FIG.18

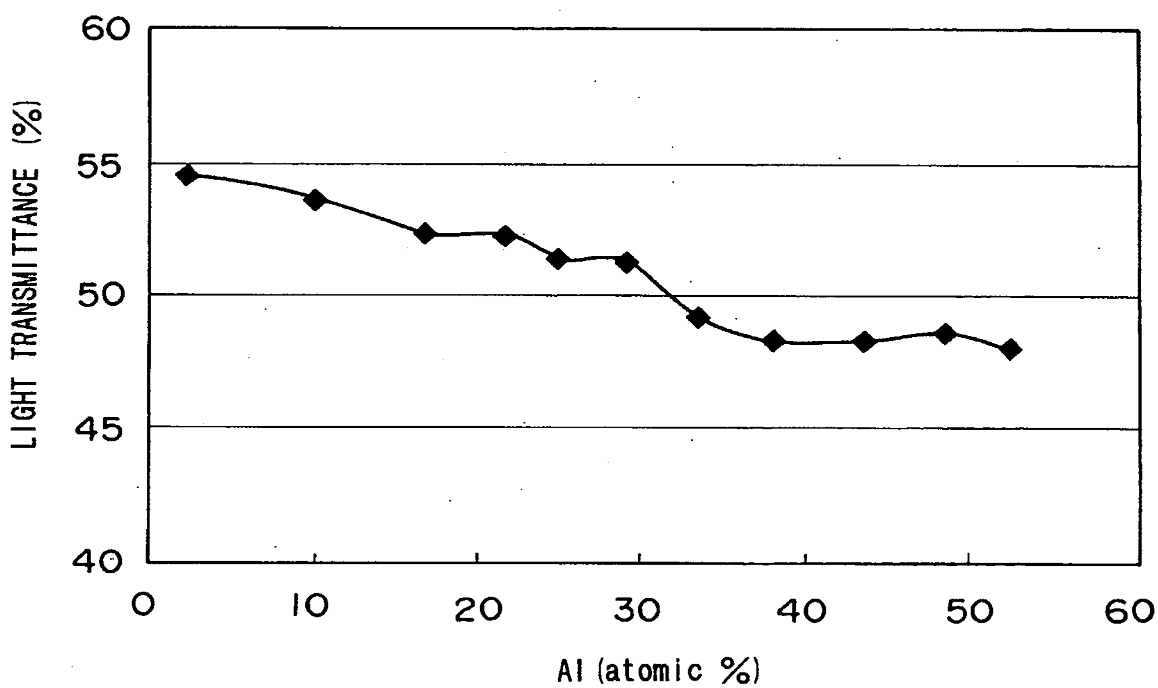

EXHIBIT B

RS

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/764,805	01/26/2004	Hironori Kakiuchi	890050.457	9756

500 7590 04/10/2008
SEED INTELLECTUAL PROPERTY LAW GROUP PLLC
701 FIFTH AVE
SUITE 5400
SEATTLE, WA 98104

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EXAMINER	
ANGEBRANNDT, MARTIN J	
ART UNIT	**PAPER NUMBER**
1795	
MAIL DATE	**DELIVERY MODE**
04/10/2008	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

2 - month Response Due: June 10, 2008
3 - month Response Due: July 10, 2008
Notice of Appeal Due: Oct. 10, 2008
(6 - month period ends) Will Go Aban
(3 - month extension of the time required)
FINAL REJECTION

ENTERED IN DOCKET
VSS

PTOL-90A (Rev. 04/07)

Office Action Summary	Application No.	Applicant(s)
	10/764,805	KAKIUCHI ET AL.
	Examiner	Art Unit
	Martin J. Angebranndt	1795

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *12/20/07 & 3/21/08*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-25* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-25* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *3/21/08*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

1. The response of the applicant has been read and given careful consideration. The certified translation of the priority document has been received and the claims are accorded the filing date of the priority document (January 28, 2003). This translation obviates the rejections of record. Response the arguments of the applicant are presented after the first rejection to which they are directed.

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

3. Claims 1-8,10-14 and 19-25 are rejected under 35 U.S.C. 103(a) as being unpatentable over **either** Xu et al. CN 1330368 or Shuy et al. '160, in view of Suzuki et al. '752 combined with either of Yoshida et al. JP 10-143919 or Aratani et al. EP 1122723.

Xu et al. CN 1330368 teaches a transparent layer of Ge, Si, GaP, InP, GaAs, InAs, ZnSb, TiO_2, Sb-Zn oxide as a transparent layer (30) and reflective layer (40) may be Ag, Al, Au, Pt, Cu, Sn, Ir, Ta and alloys and/or combinations thereof. (abstract). The transparent layer may be 5-500 nm thick (4/7-12) and the reflective layer may be 1-500 nm. (4/13-20). The example uses silicon and gold as the materials. In figure 1A, the provision of thermal manipulation layers (dielectric layers) is disclosed and the use of protective layers is disclosed. (60). The examiner has only had a spot translation made, if the applicant has a written English translation made the examiner would appreciate a copy with the next response. (Shuy et al. '160 is not the corresponding English document, although they are similar)

Shuy et al. '160 teaches a transparent layer of Ge, Si, GaP, InP, GaAs, InAs, ZnSb, TiO_2, Sb-Zn oxide as a transparent layer (30) in a thickness of 5-500 nm and reflective layer (40) may be Ag, Al, Au, Pt, Cu, Sn, Ir, Ta and alloys and/or combinations thereof in a thickness of 1-500 nm. [0026-0027]. The examples use silicon and gold as the materials. In figure 1A, the provision of thermal manipulation layers (dielectric layers) is disclosed and the use of protective layers is disclosed. (60).

Suzuki et al. '752 teaches examples 68-71, which have a substrate, a first 10 nm In alloying sublayer, a second 10 nm Te alloying sublayer, a dielectric layer, an Al reflective layer and a 10 micron UV cured layer and the layers undergo alloying to cause a change in reflectance. (26/15-54 and table 7). Examples 43-49 (table 5 teach the use of a bedding layer between the substrate and the recording bilayer (col 21). The use of In, Sn, Pb, Zn or alloys including these for the first recordinglayer is disclosed. (6/1-16). Useful second layer materials include group 5B or 6B elements, such as As,Se,Sb, Te and alloys of these with other elements including Cu, and the like (6/59-7/35) The bedding layer can be various dielectric materials and prevent moisture penetration through the substrate into the recording layers (21/40-44 & 9/59-10/22). The addition of an upper dielectric and/or reflective layer between the recording layer and UV cured protective layer is disclosed for adjusting reflectance, regulating heat conduction and preventing corrosion of the recording layer (10/53-11/26). The protective layer can be 0.1- 100 microns in thickness (9/3-7)

Yoshida et al. JP 10-143919 (machine translation attached) teaches the addition of Al to Cu in amounts of 1-30% to improve the corrosion resistance [0017]. The addition of Fe, Mn,

Au, Pt, Pd, Ti, Mo, Ta, Zr, V, W, etc in amounts of 0.1-10% to further improve the corrosion resistance is disclosed [0018]. Example 4 uses 20% Al. [0033].

Aratani et al. EP 1122723 teach reflective layer composition and exemplify $Cu_{82.5}Al_{17.5}$ (table 2, page 7). The reflective films functions to allow recording [0044-0045]. Useful Cu based alloys are disclosed. [0050-0051].

It would have been obvious to one skilled in the art to modify the examples corresponding to figure 1Aof **either** Xu et al. CN 1330368 or Shuy et al. '160 by using **Cu alloys** with less than 10-30% of Al, such as those disclosed by either of Yoshida et al. JP 10-143919 or Aratani et al. EP 1122723 in place of the Au layer with a reasonable expectation of forming a useful alloying optical recording medium based upon the disclosure of equivalence of the reflective layer materials including Cu alloys by **either** Xu et al. CN 1330368 or Shuy et al. '160, where the Cu layer does not suffer from corrosion based upon the teachings of either of Yoshida et al. JP 10-143919 or Aratani et al. EP 1122723 and to add a reflective layer between layers 50 and 60 as taught by Suzuki et al. '752 to adjust the reflectivity. Further, it would have been obvious modify the resulting media by using other disclosed transparent layer materials, such as InP, ZnSb, InAs or Ge in place of the Si used in the example with a reasonable expectation of forming a useful alloying optical recording.

In response to the arguments, the examiner notes that corrosion of Cu is known in the art as evidenced by Yoshida et al. JP 10-143919 or Aratani et al. EP 1122723 and that corrosion of the alloying layers in known in the art as evidenced by Suzuki et al. '752, which describes the addition of dielectric layers as a mode for addressing this. In the case of the addition of a reflective layer between layers 50 and 60 of figure 1A as discussed in the rejection, the recording

layer is between transparent layer 20 and the reflective layer. The claims rejected under this heading do not recite the position of the light transmission layer as the outermost layer as claims 9 and 15-18 do. The claims require at least one recording bilayer and so a single alloying bilayer is embraced by the claims, the applicants use of the 'plurality' language in the arguments is reaching and fails to clearly account for the embodiments where a single recording bilayer is used. The Xu et al. CN 1330368, Shuy et al. '160 and Suzuki et al. '752 each include alloying bilayers and so that enbodiment is clearly taught. The instant application could present data evidencing an unobvious result by comparing the Cu alloy embodiments of the claimed invention with those using only Cu in the recording layer, where the recording media are formed without contact with oxygen and kept under an inert atmosphere, such as argon or nitrogen, until testing. The applicant might use nitrides as the dielectric layer materials to accomplish this. This would allow the applicant to evidence unexpected results which are not dependent upon the anti-corrosion properties of the Cu-Al alloys of the claimed invention. Clearly, the motivation to add the Al to prevent/reduce corrosion of the Cu layer is present in the art as evidenced by Yoshida et al. JP 10-143919 or Aratani et al. EP 1122723 and further the desire to prevent corrosion in alloying recording layers is known as evidenced in Suzuki et al. '752, so the prior art of record, which is all within the optical recording media art, does serve to direct one to the addition of Al to the Cu layer.

The examiner notes that the claims are all directed to the media, and the thicknesses of the recording sub layers/bilayers is taught in the art, thereby rendering the recited reflectance properties obvious or more properly anticipated by the media rendered obvious by the rejection

above. The use of the laser need not be shown as this is not part of the medium, nor are the claims directed to the method of use.

The examiner discusses the thickness of each of the layers forming the recording bilayer to address the issue of the light transmittance of the recorded regions recited in claims 20-25. These values will be dependent upon the thickness of the layers which make up the recording bilayer. The applicant point to the data in figure 17 which evidences reduced jitter for the range of 10-30 % Al. The examiner notes that the entire range of jitter shown in that figure is ~5.5 to 7.5%, so the showing is not pronounced enough to warrant patentabilty. Further, there is a basis for the addition of Al to Cu layer to reduce corrosion in the prior art reduce corrosion. In response to applicant's arguments against the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986). The applicant admits on page 8 of the response that Shuy et al. teach alloys of Cu and Al, but fails to appreciate that the lack of a teachings of amounts/proportions is made up in the other references, which describe corrosion resistance as a reason to add Al to Cu, a benefit which would reasonably be realized in the media resulting from the combination of either Xu et al. CN 1330368 or Shuy et al. '160, in view of Suzuki et al. '752 combined with either of Yoshida et al. JP 10-143919 or Aratani et al. EP 1122723. The reduced reflectivity when too much l is present would also affect the difference in the refractivity/trnamittance of the recorded/uncrecorded areas and reduce the contrast between them. This addresses the issue of the difference in jitter raised by the applicant.

4. Claims 1-25 are rejected under 35 U.S.C. 103(a) as being unpatentable over either Xu et al. CN 1330368 or Shuy et al. '160, in view of Suzuki et al. '752 combined with either of Yoshida et al. JP 10-143919 or Aratani et al. EP 1122723, further in view of Morimoto et al. '345, Shigeta et al. JP 59-225992 and Kinoshita et al. JP 2000-285509 (machine translation enclosed).

Morimoto et al. '345 teaches that the reflective layer may be on the same side of the recording film as the substrate if topside recording is to be used and on the opposite side of the recording films from the substrate if recording is to take place through the substrate (6/42-65). The dielectric layers (metallic compounds layers) are disclosed as providing improvements in the stability and sensitivity (7/42-8/12). The prevention of direct contact with the recording layer is disclosed. (7/1-10). The protective layer can be organic materials (14/62-15/5).

Shigeta et al. JP 59-225992 teach mixing of layers (1) and (2) and establishes that the order is not important (see figures). The use of a Cu layer as the metal and SnO_2, ZnO, Al_20_3, In_20_3 oxide layers is disclosed in table 2.

Kinoshita et al. JP 2000-285509 teach with respect to drawing 1, a substrate, an Au layer, a dielectric layer, a 10 nm Al layer a Ge layer and a protective layer [0015-0016].

It would have been obvious to one skill in the art to one skilled in the art to modify the embodiments rendenred obvious by the combination of **either** Xu et al. CN 1330368 or Shuy et al. '160, cobined with Suzuki et al. '752 and either of Yoshida et al. JP 10-143919 or Aratani et al. EP 1122723 by reversing the order of the two films forming the bilayer as discussed by Shigeta et al. JP 59-225992 with a reasonable expectation of the recording medium functioning based upon the disclosure of equivalence of the two orientations and/or placing the reflective

layer between the substrate and layer 20 to allow recording with the light incident through the protective layer based upon the disclosure of the function of the reflective layer on either side by Morimoto et al. '345 and the prior use of the this ordering in the alloying media of Kinoshita et al. JP 2000-285509, which lends a reasonable expectation of success.

The rejection stands for the reasons above as no further arguments were directed at this rejection.

5. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

6. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Martin J. Angebranndt whose telephone number is 571-272-1378. The examiner can normally be reached on Monday-Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mark Huff can be reached on 571-272-1385. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Martin J Angebranndt/
Primary Examiner, Art Unit 1795

Martin J Angebranndt
Primary Examiner
Art Unit 1795

4/9/2008

EFS-Web Receipt date: 03/21/2008
Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (03-08)
Approved for use through 03/31/2008. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	10764805
	Filing Date	2004-01-26
	First Named Inventor	Hironori Kakiuchi
	Art Unit	1745
	Examiner Name	Martin J. Angebranndt
	Attorney Docket Number	890050.457

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] j	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
/M.A./	1	11-227334	JP		1999-08-24	Koichi		☐
/M.A./	2	11-328740	JP		1999-11-30	Hiroyuki et al.		☐
/M.A./	3	2001-291273	JP		2001-10-19	Yoshitaka		☐

EFS Web 2.0.3 /Martin Angebranndt/ 04/09/2008

EFS-Web Receipt date: 03/21/2008	Application Number	10764805
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Filing Date	2004-01-26
	First Named Inventor	Hironori Kakiuchi
	Art Unit	1745
	Examiner Name	Martin J. Angebranndt
	Attorney Docket Number	890050.457

/M.A./	4	2002-50076	JP		2002-02-15	Toshishige et al.		☐

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NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1		☐

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EXAMINER SIGNATURE

Examiner Signature	/Martin Angebranndt/	Date Considered	04/09/2008

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

EXHIBIT C

UNITED STATES PATENT AND TRADEMARK OFFICE

DVC

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/764,805	01/26/2004	Hironori Kakiuchi	890050.457	9756

500 7590 10/17/2008
SEED INTELLECTUAL PROPERTY LAW GROUP PLLC
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SUITE 5400
SEATTLE, WA 98104

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EXAMINER	
ANGEBRANNDT, MARTIN J	

ART UNIT	PAPER NUMBER
1795	

Response
JAN. 17, 2009

MAIL DATE	DELIVERY MODE
10/17/2008	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)
	10/764,805	KAKIUCHI ET AL.
	Examiner	Art Unit
	Martin J. Angebranndt	1795

-- *The MAILING DATE of this communication appears on the cover sheet with the correspondence address* --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *21 August 2008*.

2a)☐ This action is **FINAL**. √ 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-25* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-25* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

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3. Claims 1-25 are rejected under 35 U.S.C. 103(a) as being unpatentable over either Xu et al. CN 1330368 or Shuy et al. '160, in view of Suzuki et al. '752, Morimoto et al. '345, Shigeta et al. JP 59-225992 and Kinoshita et al. JP 2000-285509 (machine translation enclosed), combined with either of (Yoshida et al. JP 10-143919 or Aratani et al. EP 1122723),

Xu et al. CN 1330368 teaches a transparent layer of Ge, Si, GaP, InP, GaAs, InAs, ZnSb, TiO_2, Sb-Zn oxide as a transparent layer (30) and reflective layer (40) may be Ag, Al, Au, Pt, Cu, Sn, Ir, Ta and alloys and/or combinations thereof. (abstract). The transparent layer may be 5-500 nm thick (4/7-12) and the reflective layer may be 1-500 nm. (4/13-20). The example uses silicon and gold as the materials. In figure 1A, the provision of thermal manipulation layers (dielectric layers) is disclosed and the use of protective layers is disclosed. (60). The examiner has only had a spot translation made, if the applicant has a written English translation made the examiner would appreciate a copy with the next response. (Shuy et al. '160 is not the corresponding English document, although they are similar)

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Yoshida et al. JP 10-143919 (machine translation attached) teaches the addition of Al to Cu in amounts of 1-30% to improve the corrosion resistance [0017]. The addition of Fe, Mn, Au, Pt, Pd, Ti, Mo, Ta, Zr, V, W, etc in amounts of 0.1-10% to further improve the corrosion resistance is disclosed [0018]. Example 4 uses 20% Al. [0033].

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Morimoto et al. '345 teaches that the reflective layer may be on the same side of the recording film as the substrate if topside recording is to be used and on the opposite side of the recording films from the substrate if recording is to take place through the substrate (6/42-65). The dielectric layers (metallic compounds layers) are disclosed as providing improvements in the stability and sensitivity (7/42-8/12). The prevention of direct contact with the recording layer is disclosed. (7/1-10). The protective layer can be organic materials (14/62-15/5).

Shigeta et al. JP 59-225992 teach mixing of layers (1) and (2) and establishes that the order is not important (see figures). The use of a Cu layer as the metal and SnO_2, ZnO, Al_20_3, In_20_3 oxide layers is disclosed in table 2.

Kinoshita et al. JP 2000-285509 teach with respect to drawing 1, a substrate, an Au layer, a dielectric layer, a 10 nm Al layer a Ge layer and a protective layer [0015-0016].

It would have been obvious to one skilled in the art to modify the examples corresponding to figure 1Aof **either** Xu et al. CN 1330368 or Shuy et al. '160 by using **Cu alloys** with less than 10-30% of Al, such as those disclosed by either of Yoshida et al. JP 10-143919 or Aratani et al. EP 1122723 in place of the Au layer with a reasonable expectation of forming a useful alloying optical recording medium based upon the disclosure of equivalence of the reflective layer materials including Cu alloys by **either** Xu et al. CN 1330368 or Shuy et al. '160, where the Cu layer does not suffer from corrosion based upon the teachings of either of Yoshida et al. JP 10-143919 or Aratani et al. EP 1122723 and to add a reflective layer between

layers 50 and 60 as taught by Suzuki et al. '752 to adjust the reflectivity. Further, it would have been obvious modify the resulting media by using other disclosed transparent layer materials, such as InP, ZnSb, InAs or Ge in place of the Si used in the example with a reasonable expectation of forming a useful alloying optical recording and further to reverse the order of the two films forming the bilayer as discussed by Shigeta et al. JP 59-225992 with a reasonable expectation of the recording medium functioning based upon the disclosure of equivalence of the two orientations and/or placing the reflective layer between the substrate and layer 20 to allow recording with the light incident through the protective layer based upon the disclosure of the function of the reflective layer on either side by Morimoto et al. '345 and the prior use of the this ordering in the alloying media of Kinoshita et al. JP 2000-285509, which lends a reasonable expectation of success.

In response to the arguments, the examiner notes that corrosion of Cu is known in the art as evidenced by Yoshida et al. JP 10-143919 or Aratani et al. EP 1122723 and that corrosion of the alloying layers in known in the art as evidenced by Suzuki et al. '752, which describes the addition of dielectric layers as a mode for addressing this. In the case of the addition of a reflective layer between layers 50 and 60 of figure 1A as discussed in the rejection, the recording layer is between transparent layer 20 and the reflective layer. The claims rejected under this heading do not recite the position of the light transmission layer as the outermost layer as claims 9 and 15-18 do. The claims require at least one recording bilayer and so a single alloying bilayer is embraced by the claims, the applicants use of the 'plurality' language in the arguments is reaching and fails to clearly account for the embodiments where a single recording bilayer is

used. The Xu et al. CN 1330368, Shuy et al. '160 and Suzuki et al. '752 each include alloying bilayers and so that enbodiment is clearly taught. The instant application could present data evidencing an unobvious result by comparing the Cu alloy embodiments of the claimed invention with those using only Cu in the recording layer, where the recording media are formed without contact with oxygen and kept under an inert atmosphere, such as argon or nitrogen, until testing. The applicant might use nitrides as the dielectric layer materials to accomplish this. This would allow the applicant to evidence unexpected results which are not dependent upon the anti-corrosion properties of the Cu-Al alloys of the claimed invention. Clearly, the motivation to add the Al to prevent/reduce corrosion of the Cu layer is present in the art as evidenced by Yoshida et al. JP 10-143919 or Aratani et al. EP 1122723 and further the desire to prevent corrosion in alloying recording layers is known as evidenced in Suzuki et al. '752, so the prior art of record, which is all within the optical recording media art, does serve to direct one to the addition of Al to the Cu layer.

The examiner notes that the claims are all directed to the media, and the thicknesses of the recording sub layers/bilayers is taught in the art, thereby rendering the recited reflectance properties obvious or more properly anticipated by the media rendered obvious by the rejection above. The use of the laser need not be shown as this is not part of the medium, nor are the claims directed to the method of use.

The examiner discusses the thickness of each of the layers forming the recording bilayer to address the issue of the light transmittance of the recorded regions recited in claims 20-25. These values will be dependent upon the thickness of the layers which make up the recording bilayer. The applicant point to the data in figure 17 which evidences reduced jitter for the range

of 10-30 % Al. The examiner notes that the entire range of jitter shown in that figure is ~5.5 to 7.5%, so the showing is not pronounced enough to warrant patentabilty. Further, there is a basis for the addition of Al to Cu layer to reduce corrosion in the prior art reduce corrosion. In response to applicant's arguments against the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986). The applicant admits on page 8 of the response that Shuy et al. teach alloys of Cu and Al, but fails to appreciate that the lack of a teachings of amounts/proportions is made up in the other references, which describe corrosion resistance as a reason to add Al to Cu, a benefit which would reasonably be realized in the media resulting from the combination of either Xu et al. CN 1330368 or Shuy et al. '160, in view of Suzuki et al. '752 combined with either of Yoshida et al. JP 10-143919 or Aratani et al. EP 1122723. The reduced reflectivity when too much l is present would also affect the difference in the refractivity/transmittance of the recorded/unrecorded areas and reduce the contrast between them. This addresses the issue of the difference in jitter raised by the applicant.

In response to the arguments of 08/21/2008, translation of JP 59-225992 and CN 1330368 are made of record. These were of record in application 10/406109 as of 01/024/08. It is clear in the office actions that the examiner is relying upon the documents themselves. The amendment to the claims limits the claims to embodiments where the reflective layer is on the substrate side of the recording bilayer as otherwise the light does not reach the recording bilayer when exposed through the protective layer. The claims merely add the reflective layer between

the substrate and dielectric layer adjacent the recording bilayer of Xu et al. CN 1330368 or Shuy et al. '160 in a manner similar to that shown in Suzuki et al. '752, but on the opposite side of the recording bilayer from that exemplfied in the Suzuki et al. '752 reference. The viability of this alternative ordering is provided by Morimoto et al. '345 and Kinoshita et al. JP 2000-285509, who teach the use of the reflective layer adjacent to the substrate and Shigeta et al. JP 59-225992 who teaches the equivalence of the order of the two layers which form the recording bilayer. In response to applicant's arguments against the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986). It is well appreciated that two materials having a different electromotive potential in contact will cause corrosion of one of these. The most common example of this is copper in contact with other metals, such as Al or Fe as these are common building materials used together and cause leaks in the water pipes of homeowners. The effects of corrosion on copper layers in optical recording media is appreciated in the art as is the use of alloying to ameliorate its effects as evidenced by Yoshida et al. JP 10-143919 and Aratani et al. EP 1122723. The applicant may have a basis for arguing that the thickness of the layers forming the recording bilayers is optimized for recording/readout with lasers operating in the 380-450 nm range. The language describing the small transmittance differences fails to appreciate that with the reflective layer, the recording process uses the change in the refractive index of the bilayer areas and the mixed areas as discussed in Suzuki et al. at 7/58-6/19 (push-pull). Therefore the change in the transmittance is not relied upon as argued/implied by the applicant and there is no benefit ascribed to this. The examiner notes that

at this point the position argued is one of intended use as there are no method claims under prosecution.

4. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Martin J. Angebranndt whose telephone number is 571-272-1378. The examiner can normally be reached on Monday-Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mark Huff can be reached on 571-272-1385. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Martin J Angebranndt/
Primary Examiner, Art Unit 1795

Martin J Angebranndt
Primary Examiner
Art Unit 1795

10/14/2008

Notice of References Cited	Application/Control No. 10/764,805	Applicant(s)/Patent Under Reexamination KAKIUCHI ET AL.	
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U.S. PATENT DOCUMENTS

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NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	translation of JP 59-225992
	V	translation of CN 1330368
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.